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ACHIEVEMENT AND CRITICAL THINKING IN MATHEMATICS IN RELATION TO LEARNING SETS, ANXIETY AND INTELLIGENCE

by

HARDIAL S. PANNU

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Achievement and Critical Thinking in Mathematics in Relation to Learning Sets, Anxiety, and Intelligence," submitted by Hardial S. Parnu in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The purpose of this research was to determine the relationship between (1) the learning performance and (2) critical thinking of students in Mathematics with (a) the types of mathematical quizzes that they took, (b) their intelligence, (c) test anxiety, and (d) sex.

The sample consisted of 190 grade twelve students (113 males and 77 females) who were taking Mathematics 30. Six classes of four teachers took part in the study. Two teachers taught two classes each and two taught one class each. All subjects were given Otis-Lennon Mental Ability Test, Watson-Glaser Critical Thinking Appraisal, and Test Anxiety Scale. All the students of a class were taught by the same teacher in the same classroom. Each teacher randomly divided his class into two groups. One group was always given higher level quizzes (Level 2, 3, and 4 according to Bloom's Taxonomy) and the other group was always given lower level quizzes (Level 1 in Bloom's Taxonomy). Thus 94 students were always given higher level quizzes and 96 students lower level quizzes. All subjects wrote the same final examination which consisted of 33 questions, 13 at lower level and 20 at higher levels. Treatment X Sex X Intelligence (2X2X3) analyses of variance were carried out, using the scores on the lower level questions of final examination, separately those on the higher level questions of final examination, and the scores on the Watson-Glaser

Critical Thinking Appraisal.

There was no significant difference in the scores on the lower level quizzes between the two groups, but the students who were given higher level quizzes performed significantly better in the higher level questions of the final examination. Males performed significantly better than females in the higher level questions but not so in the lower level questions. High intelligence students performed significantly better than low intelligence students in both the higher and lower level questions. Significant difference in critical thinking ability was found between the two groups, the two sexes and also the three levels of intelligence when the Treatment X Sex X Intelligence (2X2X3) analysis of variance was performed, using the scores of the Watson-Glaser Critical Thinking Appraisal as criterion. The critical thinking ability was higher for higher intelligence, for males and also for the students who were given the higher level quizzes.

Anxiety was found not to be associated to learning performance, but low test anxiety students did significantly better than the medium and the high test anxiety students in the Critical Thinking Appraisal.

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CHAPTER I

THE NATURE AND SIGNIFICANCE OF THE PROBLEM

Introduction and Background

The development of the ability to think is often recognized as an important objective of public education. According to the Educational Policies Commission (1961), "The purpose which runs through and strengthens all other educational purposes - the common thread of education - is the development of the ability to think (p. 12)". While researchers in education attempt to create a more favorable learning environment by striving to devise materials, learning conditions, and teaching methods that will help develop reasoning ability, the individual teacher faces the problem of selecting the appropriate methods and materials to foster the development of thinking. Teachers have often been criticised for making students memorize facts without helping them to understand, analyze, and apply the same to other situations (Bensen 1967; Davis & Hunkins, 1966; Doak, 1969, 1970; Guszak, 1967; Pfeiffer & Davis, 1965; Sanders, 1966). The Educational Policies Commission (1959) stated:

> The quality of the teaching in a given classroom largely influences whether a pupil learns a subject or learns instead to dislike it; whether he learns to interpret, evaluate and use subject matter, or merely to memorize it; whether he comes to appreciate the value of learning, or learns to seek knowledge only in response to authority (pp. 9-10).

How can this ability to reason, that educators so highly and so often consider crucial, be developed? Is there a particular body of knowledge that will of itself develop this ability? Or does it depend on a teacher or on a method of teaching?

No doubt, a body of knowledge is needed as raw material for developing critical thinking, but a particular body of knowledge does not of itself bestow this ability on a student. If it did, then the educators would merely have to identify and impart that body of knowledge.

Gage (1963), in the handbook of research on teaching, pointed out the inconclusive and insignificant results of research on teaching effectiveness. The Committee on Teacher Effectiveness of the American Educational Research Association believed

> one can point to few outcomes that a superintendent of schools can safely employ in hiring a teacher or granting him tenure, that an agency can employ in certifying teachers, or that a teacher-education faculty can employ in planning or improving teacher-education programs (Barr, Bechdolt, Gage, Orleans, Pace, Remmers & Ryans, 1953, p. 657).

Ryans (1960) believed that little progress had been made in supplementing the definition of teaching effectiveness (p. 2). Biddle and Ellena (1964) reported, "We do not today know how to select, train for, encourage, or evaluate teacher effectiveness (p. vi)."

According to Bloom (1965), "Research on teaching must, in most cases, make use of measures of cognitive achievement

(p. 379)."

Aschner (1961), Bradley (1966), Carner (1963), Ebel (1969), Link (1963), Miller (1966), Pfeiffer & Davis (1965), and Van Til (1961) recognized the importance of questions as a means of stimulating and developing thinking ability.

According to Aschner (1961), "Asking questions —in class discussion or on assignments and tests — is one of the basic ways by which the teacher stimulates thinking and learning (p. 44)." Aschner (1961) believed asking questions stimulated four main types of thinking activities, i.e., remembering, reasoning, evaluating or judging and creative thinking. He felt that all of these should go on hand in hand in any classroom.

Pfeiffer & Davis (1965), after analysing the semester examinations for all ninth grade courses during the year 1963-64 in Northern Ohio, were alarmed over the lack of questions in the area of analysis, synthesis, and evaluation. Davis & Hunkins (1966) found it depressing that 87% of the questions in the Social Studies text books for grade five were knowledge questions, implying that the higher level questions were needed to stimulate or develop higher cognitive skills.

If questions are considered by educators and psychologists to be so important for stimulating thinking ability, then certainly some attention should be paid to this area. Lombard (1965) reminded teachers, "your tests

are as important as your teaching (p. 38)." Bradley (1966) felt, "we pay less attention to the structuring of questions for purposes of enhancing learning activities than we would care to admit (p. 14)."

A taxonomy of educational objectives for classifying, for assessing the students' thinking skills, and for evaluating learning in terms of student behavioral changes was developed and described in a handbook edited by Bloom (1956). It is a tool for a creative approach to test construction, "Although the Taxonomy is intended to have universal application, it is particularly relevant to mathematics where most significant behaviors appear to have cognitive origins (Wood, 1968, p. 86)." But "there is still a tendency not to assess the students' ability to utilize or apply newly acquired knowledge and skills (Klausmeir, 1969, p. 1490)." An annotated bibliography of 116 studies involving the Taxonomy by Cox and Wildermann (1970) revealed that little research had been carried out to determine the effects of various types of questions on the achievement and critical thinking of the students.

The authors of the Taxonomy of educational objectives: cognitive domain stated that item difficulty is not necessarily related to the complexity of intellectual processes measured by the items. Guttman (1954), in presenting the theory and method of simplex analysis, wrote:

> There is some danger of confusing the notion of degree of complexity with that of difficulty. If we say that subtration is more complex than addition, we do not mean by this that subtraction is necessarily more difficult than addition. Complexity and difficulty have no necessary connection with each other (p. 283).

The Taxonomy is considered to be hierarchical. Because of this hierarchical principle, it has been argued that items measuring the more complex processes are, by their very nature, more difficult than items measuring the less complex processes. No empirical study has shown that a relationship does indeed exist between complexity and difficulty.

It has been established, however, that there is a relationship between anxiety and performance. The specific anxiety measures (test anxiety scales) are more highly correlated with academic achievement than the general anxiety measures. They are better predictors of academic performance than are general anxiety scales and are able to account for variance in academic achievement beyond that accounted for by aptitude measures (Alpert & Haber, 1960; Carrier & Jewell, 1966). There is a danger, then, that differences in learning performance might be a result of test anxiety rather than level of quizzes. Precautions must be taken to avoid such confounding of the variables.

The Nature and Significance of the Problem

This study attempted to determine the relationship between the types of mathematics quizzes (treatment) to

which the students are exposed during a period of time with the student's critical thinking and learning performance. Answers to several specific questions were sought. Do the students who are always given the higher level (levels 2, 3, and 4, in the Bloom's Taxonomy) quizzes or those always given the lower level (level 1 in the Taxonomy) quizzes as a part of regular classroom experience perform better in the low level questions of the final examination (dependent variable)? Is there any difference in the performance of the students in the higher level questions of the final examination? Is the critical thinking and learning performance of the students who have been subjected to different types of quizzes influenced by other independent variables such as intelligence, test anxiety, or sex of the students?

Psychological research is replete with studies dealing with questions and questioning (Aschner, 1961; Aubertine, 1968; Bradley, 1966; Carner, 1963; Class, 1935; Davis & Hunkins, 1965; Davis & Tinsley, 1967; Doak, 1970; Ebel, 1969; Guszak, 1967; Jeffery, 1969; Johnson, 1955; Kleinman, 1965; Link, 1963; Miller, 1966; Pfeiffer & Davis, 1965; Sanders, 1966; Torrance & Harmon, 1961; and Young, 1961). There is no dearth of studies showing the lack of higher level questions used by the teachers (Davis & Hunkins, 1966; Davis & Tinsley, 1967; Doak, 1970; Pfeiffer & Davis, 1965; and Sanders, 1966).

The development of the ability to think and the stimulation of cognitive processes is important to education. If the use of higher level questions helps the students learn how to organize, analyze, evaluate and judge ideas and concepts, then the educators should emphasize questions of this type. On the other hand, if the use of lower level questions serves the same purpose as the higher level questions, the researchers should stop complaining about the lower level questions so often used by teachers. If the levels of questions do not make any difference in the achievement and critical thinking of the students then the researchers and the educators should look at other factors.

The findings of the study will have vital implications for educational planning, the specific objectives of a curriculum, and evaluation of achievement.

CHAPTER II

REVIEW OF RELATED RESEARCH

The review of research has been divided into three parts. The first part deals with the level and types of teachers' questions, the second part deals with the comparisons among several taxonomic classifications, and the third part deals with test anxiety.

Levels and Types of Teachers' Questions

Early in the century Stevens (1912) provided evidence that teachers' questions, during class, emphasized memory. The more recent studies (Davis & Hunkins, 1966; Davis & Tinsley, 1967; Doak, 1970; Guszak, 1967; Pfeiffer & Davis, 1965) show that teachers today have not changed much, in that they still emphasize fact-questions. For instance, Guszak (1967) found that 70.4% of teachers questions were confined to memory.

Davis & Tinsley (1967) observed that memorizing facts was the major cognitive objective of teachers' classroom questions. In fact, they report that the students and teachers' questions were either at level one or two as defined by Bloom (1956).

Doak (1970), after studying verbal behavior in the classroom by utilizing time-sampling techniques, indicated that more than 90% of classroom verbalization was at levels

one and two according to Bloom's Taxonomy (1956),

> much teaching, regardless of the ability level of the student, is directed toward the transferring--on the part of the teacher--and absorbing--on the part of the students--of factual information (Doak, 1970, p. 178).

The emphasis on memory questions is not restricted to the classroom verbalization. The tests made by the teachers and the text-book questions also emphasize memory.

Pfeiffer & Davis (1965) secured the semester examinations for all ninth grade courses during the year 1963-64 from a junior high school in Ohio and observed that 100% of the questions in civics, home economics and biology; 95% of the questions in business training; 58% of the questions in general mathematics and 52% of the questions in algebra were in the knowledge classification. They felt that

> recognition that knowledge is fundamental to all other cognitive goals is certainly not justification for emphasizing its acquisition to the exclusion of thinking processes (p. 10).

Davis & Hunkins (1966) classified the questions from three fifth grade Social Studies text books and found that 87% of the questions were at the knowledge level.

Torrance & Harmon (1961) were shocked to find that the students in the graduate course in mental hygiene did not even expect to be able to use the knowledge they were acquiring.

Sanders (1966) also supports the view that teachers overemphasize the knowledge level and states "many teachers offer students too few questions requiring translation,

interpretation, application, analysis, and evaluation (p. 5)."

Kleinman (1965) reported that the teachers who asked relatively large numbers of critical-thinking questions imparted a significantly better understanding of science to high ability seventh and eighth grade students.

Doak (1970) also observed a high degree of congruence between teacher and pupil levels of thinking and states "it appeared that the students were fulfilling the teachers' objective successfully (p. 178)." Guszak (1967) is in agreement with Doak and found that "students invariably are sensitive to 'what teachers want' and generally do a good job of supplying it (p. 227)." Ebel (1969) and Carner (1963) also support the view that a teacher's questions have a controlling effect upon students' learning.

Aubertine (1968), Class (1935), Jeffery (1969), Johnson (1955), Torrance & Harmon (1961) and Young (1961) agree that the type of questions or tests given determine the set adopted by pupils during study. For the purpose of this study the definition of set will be the one given by Aubertine (1968).

> A set is a cognitive process activated by a stimulus or stimuli perceived by a person in environmental situations, determining how one is predisposed to respond to what is attended to in a given situation (p. 363).

Comparison of Several Taxonomic Classifications

Since instruction in any subject field is intended to help students acquire certain abilities and skills an effort

is usually made to spell out objectives and to select learning experiences necessary to bring them about. It is futile to state objectives unless an effort is made to achieve them and then to evaluate this attainment. When one tries to analyze human performance one ends up with large masses of details. "The fundamental reason for this, of course, is that human performance is complex (Gagné, 1965 (a) p. 17)." It is very difficult if not impossible to deal with this great number of individual facts, but as one goes on analyzing these objectives the different varieties of human performance begin to fall into categories. The purposes of this classification system are similar to those of biological taxonomies. Several classifications of educational objectives are available, the one that bases its categorization on logical and psychological principles should be preferred.

Condensed Version of the Taxonomy of Educational Objectives. Cognitive Domain

In 1948 a group of college examiners attending the American Psychological Association Convention in Boston decided to develop a structure that could assist test makers as well as instructors in general. They wanted some theoretical framework that could help them to communicate with one another about testing materials, a framework that could stimulate thought and research dealing with educational problems. They agreed "that such a theoretical framework might best be obtained through a system of classifying the

goals of the educational process (Bloom, 1956, p. 4)."

The taxonomy is not a classification of instructional materials or the instructional methods used by the teacher. It is the classification of "the ways in which individuals are to act, think or feel as the result of participating in some unit of instruction (Bloom, 1956, p. 12)." It is an educational logical-psychological classification system. The condensed version of the taxonomy is given below (Bloom, 1956, pp. 201-207).

1:00 Knowledge (This involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure or setting).

1:10 Knowledge of specifics

1.11 Knowledge of terminology

1.12 Knowledge of specific facts

1:20 Knowledge of ways and means of dealing with specifics

1,21 Knowledge of conventions

1.22 Knowledge of trends and sequences

1.23 Knowledge of classifications and categories

1.24 Knowledge of criteria

1.25 Knowledge of methodology

1:30 Knowledge of the universals and abstractions in a field

1.31 Knowledge of principles and generalizations

1.32 Knowledge of theories and structures

2:00 Comprehension (This represents the lowest level of understanding, where the individual knows what is being communicated and can use it without necessarily relating it to other material or seeing its full implications).

2.10 Translation

2.20 Interpretation

2.30 Extrapolation

3:00 Application (This involves the use of abstractions in particular and concrete situations).

4:00 Analysis (This involves the breakdown of a communiction into its constituent elements, such that the relative hierarchy of ideas is made clear and that the relations between the ideas expressed are made explicit).

4.10 Analysis of elements

4.20 Analysis of relationships

4.30 Analysis of organizational principles

5:00 Synthesis (This involves the process of working with pieces, parts or elements, and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before).

5.10 Production of a unique communication

5.20 Production of a plan or proposed set of operations

5.30 Derivation of a set of abstract relations

6:00 Evaluation (This involves judgments about the value of material and methods for given purposes. The criteria used may be those determined by the student or those which are given to him).

6.10 Judgments in terms of internal evidence

6.20 Judgments in terms of external criteria

Studies Dealing with Bloom's Taxonomy

Avital (1967), Kropp, Stoker & Bashaw (1966b), McGuire (1963) and Stanley & Bolton (1957) deal with the classification of items by judges.

In McGuire's (1963) study, a panel of three members independently classified items in the 1961 National Board Examination of the National Board of Medical Examiners. The raters used an eight-level adaptation of the Taxonomy. It was observed that 61% of the items received identical ratings from all the three raters, 93% of the items received identical ratings from two or more raters and only in 7% of the items did all three raters disagree.

In a study by Stanley & Bolton (1957) eight graduate students independently classified 227 items of the Specimen Objective Test Items, A Guide to Achievement Test Construction, into an exact subcategory. Results indicate that four or more raters agreed on 72% of the items. Stanley & Bolton report that the agreement among eight raters was quite high

when only the six major levels were taken into account.

Kropp, Stoker & Bashaw (1966b) in a three-year long series of studies to explore the construct validity of the Taxonomy, reported that trained raters can classify test items into taxonomy categories with very high degrees of agreement.

Harasym (1970), Hunkins (1967, 1969), Kropp et al (1966) and McGuire (1963) deal with the analyses of Taxonomy-type data.

Hunkins (1967) investigated the effect of the various types of questions, classified according to Bloom's Taxonomy, on pupils overall social studies achievement and observed that the use of high-level analysis and evaluation questions produce significantly greater scores in social studies test than did lower level or knowledge questions.

Hunkins (1969) observed absolutely no significant difference in the pupils' ability to deal with the knowledge questions when the pupils who received high-cognitive level questions were compared with the pupils who received low cognitive level questions.

Harasym (1970) undertook a study dealing with the effects of three cognitive levels of questions on achievement of social studies and observed no significant difference. Harasym had a short treatment period which was a major weakness of his study.

McGuire (1963) in a study mentioned earlier, found

hierarchical and cumulative characteristic of the Taxonomy. She observed the higher correlation between the adjacent levels than between the widely separated levels. Kropp et al (1966) supported the imputed hierarchical structure of the Taxonomy. The hierarchical nature of the Taxonomy is supported by Anderson (1964), Kropp, Stoker & Bashaw (1966a), McGuire (1963), Stoker & Kropp (1964), and Stoker & Kropp (1966).

Gagné's Classification

Gagné (1963 a,b; 1964 a,b; 1965 a,b) attempted an extensive analysis of learning types and tried to translate these into educational objectives. He talks about Response learning, Chaining, Verbal learning, Concept learning, Principle learning and Problem solving. It must be pointed out that Gagné is "inconsistent in the number of learning types in the various publication (Avital, 1967, p. 33)" but the ones cited above seems to be most valid separate entities. The hierarchy postulated by Gagné refers to the actual act of solving a problem.

In 1964 Gagné was critical of Bloom's Taxonomy because "it cannot clearly distinguish a similar variety of learning experiences (1964a, p. 38)" but later on Gagné expressed a very positive attitude towards the Taxonomy. Referring to the Taxonomy he wrote:

> Although there is not a one-to-one correspondence of these categories with those I have outlined, there are definable relationships between them, and the similarity of the basic idea is apparent (Gagné 1965a, p. 21).

The extent to which the Taxonomy has been used is mentioned earlier in this chapter and also in Chapter 1. Here, an attempt will be made to look into some other classifications and see if they are not merely adaptations of the Taxonomy. All these classifications refer specifically to mathematics and an attempt is made to summarize them in the wordings of the authors.

The International Study of Achievement in Mathematics Classification

The International Study of Achievement in Mathematics attempted

> to test a number of fundamental hypotheses relating to the outcomes of different patterns of educational organizations set in a variety of social and cultural contexts (Husén, 1967, p. 13).

To measure the achievement in Mathematics the measuring instruments had to be constructed. These instruments had to be appropriate for application in the schools of different nations. "The overall objective in the test construction was to arrive at internationally valid measuring instruments covering a wide range of content and objectives (Husén, 1967, p. 47)."

After getting reports from the twelve countries on the content and objectives of mathematics learning of pupils from the 13-year-old to the pre-University level an

international committee proposed that the test items should cover the following categories of intellectual process.

A. Knowledge and information: recall of definitions, notations, concepts.

B. Technique and Skills: manipulation and computation.

C. Translation of data into symbols or schemes and vice versa.

D. Comprehension: capacity to analyze problems, to follow reasoning.

E. Inventiveness: reasoning creatively in mathematics.

The Item Bank Project Classification

Wood (1968) suggested the Item Bank Project Classification of behavioral objectives in order to stimulate the thoughts of CSE mathematics teachers. This was proposed as an alternative method of calibrating attainment in the CSE examination. The classification system, which was very brief, is given below.

A. Knowledge and information: recall of definitions, notations, concepts.

B. Technique and Skill: computation, manipulation of symbols.

C. Comprehension: capacity to understand problem, to translate symbolic forms, to follow and extend reasoning.

D. Application of appropriate concepts in unfamiliar mathematical situations.

E. Inventiveness: reasoning creatively in mathematics.

Wood, the author of this classification admits that these headlines are very reminiscent of the International Study of Achievement in Mathematics Classification (Wood, 1958, p. 89).

Indian National Council of Educational Research Classification

When the Department of Curriculum and Evaluation at the National Institute of Education at New Delhi ran a training course on educational evaluation in October, 1966 the participants were given the following classification of instructional objectives in mathematics (Wood, 1968).

Objective I. The pupil acquires Knowledge of mathematical terms, symbols, concepts, assumptions, principles, formulae and processes.

The pupil

(i) recalls mathematical terms, definitions, formulae, principles and processes.

(ii) recognizes terms, instruments, processes, etc.

Objective II. The pupil develops Skill in

(a) handling the mathematical instruments.

(b) drawing geometrical figures and graphs.

(c) reading tables, charts, graphs, etc.

(d) computation.

(e) handling mathematical instruments:

The pupil

(i) handles mathematical instruments with ease.

(ii) takes necessary precautions in using mathematical instruments.

(iii) takes measurements with accuracy and speed.

(b) Drawing geometrical figures and graphs:

The pupil

(i) draws satisfactory freehand figures.

(ii) draws figures and graphs to given specifications.

(iii) draws figures and graphs neatly, quickly and accurately.

(iv) draws figures and graphs to scale.

(c) Reading tables, charts, graphs, etc.:

The pupil

(i) reads tables, charts and graphs quickly and accurately.

(ii) co-ordinates different parts of a table, graph or chart.

(d) Computation:

The pupil

(i) does oral calculations with speed and accuracy.

(ii) does written calculations with speed and accuracy.

(iii) does written work systematically.

Objective III. The pupil acquires understanding of mathematical terms, symbols, concepts, principles, formulae and processes.

The pupil

(i) gives illustrations for mathematical concepts, terms, principles, processes, etc.

(ii) explains mathematical terms, concepts, principles, etc. in his own words.

(iii) detects errors in definitions, processes, etc.

(iv) identifies mathematical relationships in different situations.

(v) compares related mathematical concepts, processes, figures, etc.

(vi) discriminates between closely related concepts, terms, processes, etc.

(vii) verbalizes symbolic relationships and vice versa.

(viii) verifies results.

Objective IV. The pupil Applies the knowledge of mathematics to unfamiliar situations.

The pupil

(i) reduces an unfamiliar situation to a familiar situation.

(ii) establishes relationships among the data.

(iii) judges the adequacy, inadequacy or superfluity of data.

(iv) selects most appropriate formulae, method or process to solve a problem.

(v) makes generalizations.

(vi) draws inferences.

(vii) estimates results.

(viii) predicts on the basis of given data.

The College Entrance Examination Board Classification

The College Entrance Examination Board used the following list to construct mathematics achievement test in 1960.

1. Manipulative skills and abilities.
2. Knowledge and understanding of formulae, theorems and mathematical terms.
3. Ability to translate sentences into algebraic or graphic form, and conversely the ability to interpret algebraic or graphic representation.
4. Ability to draw conclusions from data given.
5. Ability to recognize which facts or processes are necessary for the solution of a problem, and to use these accurately in the solution.
6. Ability to visualize forms and relationships in three dimensional space, and to apply knowledge of algebra, plane geometry, or trignometry, as well as solid geometry, to problems involving them.

1 and 2 correspond to category 1 of the Bloom Taxonomy; 3 and 4 to category 2 of the Taxonomy, and 5 falls in category 3 of the Taxonomy.

School Mathematics Study Group Classification

Dissatisfaction with the prevailing notions of content

validity led the School Mathematics Study Group to the conclusion that there are many components of mathematical ability rather than a single unitary trait. To establish content validity

> First one must define carefully the units of subject matter and the behaviours associated with those units . . . . And second, one must establish a sampling procedure so that the appropriate behaviours are adequately measured (Wood, 1968, p. 88).

The following schemes map the universe of behaviours which emerged (Wood, 1968, p. 88).

Knowing:	Knowing terminology, facts, and rules.
Translating:	Changing from one language to another Expressing ideas in verbal, symbolic, or geometric form Codifying patterns.
Manipulating:	Carrying out algorithms Using techniques.
Choosing:	Making comparisons Selecting appropriate facts and techniques Guessing Estimating Changing one's approach Selecting new symbolism.
Analysing:	Analysing data Finding differences Recognizing relevant and irrelevant information Seeing patterns, isomorphism, and symmetries Analysing proofs Recognizing need for additional information Recognizing need for proof or counter example.
Synthesizing:	Specializing and generalizing Conjectuing Formulating problems Constructing a proof or a problem.

Evaluating: Validating answers
Judging reasonableness of answers
Validating the solution process
Criticizing proofs
Judging the significance of a problem.

All the above classifications can be said to have been inspired by the Taxonomy and the affinities with the Taxonomy has either been acknowledged or is very clearly evident.

Studies Dealing with Test Anxiety

Alpert & Haber (1960), Carrier & Jewell (1966), Chansky (1966), Gaudry & Spielberger (1970), Harleston (1962), Ruebush (1960), Spielberger (1966) and Stennet (1967), have established that a relationship does exist between anxiety and performance. Studies (Alpert & Haber, 1960, and Carrier & Jewell, 1966) have shown that test-anxiety scales account for variance in academic performance beyond that accounted for by aptitude measures. Carrier & Jewell (1966) and Chansky (1966) have found that anxiety influences academic performance differently in boys and girls.

Summary

Questioning is one of the most widely used instructional tools used by teachers and most of the time the questions are at a low cognitive level and require the students to memorize facts.

Studies have shown that the type of questions used by the teachers cause a set formation and this has a

controlling effect on students' learning. The students supply the teachers with what they want, and there is a high degree of congruence between students' and teachers' levels of thinking.

Research dealing with Bloom's Taxonomy has established that there is a high degree of agreement when the raters classify items in a test according to the six levels of the Taxonomy. The Taxonomy is hierarchical in nature.

The fact that a relationship exists between level of anxiety and academic performance and that anxiety influences performance differently in boys and girls has been well established.

CHAPTER III

DESCRIPTION OF INSTRUMENTS, EXPERIMENTAL PROCEDURE AND VARIABLES

The procedure in general was to form two groups of students and to instruct them in the same way and to give them the same final examination. One group, however, was given quizzes made up of lower level items, while the other group's quizzes consisted of higher level items. Performance of the two groups on the final examination was then compared.

As mentioned earlier, an attempt was also made to study the relationship between the type of quizzes the students were given and their critical thinking, therefore an instrument for measuring critical thinking was needed. The study was also concerned with the relationship that intelligence and test anxiety might have on achievement quizzes and critical thinking, therefore, tests of intelligence and test anxiety were needed.

Instruments

The following instruments were used in the study.

a) Lower Level Quizzes Set I.

b) Higher Level Quizzes Set I.

c) Final Examination I.

d) Lower Level Quizzes Set II.

e) Higher Level Quizzes Set II.

f) Final Examination II.

g) Watson-Glaser Critical Thinking Appraisal.

h) Otis-Lennon Mental Ability Test.

i) Test Anxiety Scale.

Quizzes and Final Examinations: Instruments (a) to (f)

The subject matter covered by the teachers consisted of first, fourth and fifth chapters of Secondary School Mathematics Grade Twelve, (see Appendix).

The experimenter made seven quizzes based on the subject matter of the first chapter. Next he spent some time with three qualified and experienced teachers discussing the various categories in Bloom's Taxonomy. The condensed version of the Taxonomy was supplied to each of the three teachers. After this, the teachers rated each question in the quizzes according to Bloom's Taxonomy. The experimenter selected those questions that received the same rating from all the three judges and administered these quizzes to more than one hundred students. The responses were used for item analysis. The experimenter then made a set of seven lower level quizzes containing questions rated as knowledge questions. Six of these quizzes had twelve questions each while the seventh quiz had six questions only. Similarly, a set of seven higher level quizzes comprised of questions rated as Comprehension, Application or Analysis was formed. Six of the quizzes had thirteen questions each and the seventh contained seven questions.

Two questions from each lower level quiz containing twelve questions and three questions from each higher level quiz containing thirteen questions, along with one and two questions from the remaining lower and higher level quiz respectively were taken at random. These questions formed the final examination on Chapter I. This examination was labelled Final Examination I. Thus the Lower Level Quizzes Set I and the Higher Level Quizzes Set I each contained seven quizzes with ten questions in each of the six quizzes and five questions in the seventh quiz.

The experimenter repeated the same procedure of making three quizzes and a final examination on Chapter IV and V. But this time there were twelve and thirteen questions in every lower and higher level quiz respectively. Two questions from each lower level quiz and three questions from each higher level quiz were taken at random to form Final Examination II and every quiz in the Lower Level Quizzes Set II and the Higher Level Quizzes Set II was left with ten questions.

While the items comprising the final examination were judged to be of different thought process level, as defined by Bloom, a further check on whether a hierarchy was actually present was carried out. For Final Examination I, items were grouped according to their taxonomy category, which, in effect, produced four subtests. The intercorrelations of these four subtests were found to determine the

order of complexity. The results of this procedure are shown in Chapter IV.

Watson-Glaser Critical Thinking Appraisal

Watson and Glaser (1964) view critical thinking as a composite of attitudes, knowledge and skills.

> This composite includes: (1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid references, abstractions, and generalizations in which the weight or accurary of different kinds of evidence are logically determined; and (3) skills in employing and applying the above attitudes and knowledge (p. 19).

Rust, Jones & Kaiser (1962) explored the domain of critical thinking by factor analysis, obtaining three factors. Two factors, General Reasoning and Logical Discrimination or Application of Logical Principles were fairly strong but the third factor called Semantics or Verbal Understanding was less clear.

Guilford's factor-analytic studies (Guilford, 1965) shed light on the relationship between critical thinking and intelligence. Cognition (discovery) factors, production (solution) factors and evaluation (relative suitability) factors were the three factors that Guilford found most pertinent in problem solving. This is very much like the Watson-Glaser view of critical thinking.

Watson-Glaser Critical Thinking Appraisal is a revision of the Watson-Glaser Tests of Critical Thinking.

It is available in two forms, YM and ZM. Each form consists of five subtests which are described in the Manual. (Watson & Glaser 1964, p. 2) as follows:

Test 1. Inference. (Twenty items). Samples ability to discriminate among degrees of truth or falsity of inferences drawn from given data.

Test 2. Recognition of Assumptions. (Sixteen items). Samples ability to recognize unstated assumptions or presuppositions which are taken for granted in given statements or assertions.

Test 3. Deductions. (Twenty-five items). Samples ability to reason deductively from given statements or premises; to recognize the relation of implication between propositions; to determine whether what may seem to be an implication or a necessary inference from given premises is indeed such.

Test 4. Interpretation. (Twenty-four items). Samples ability to weigh evidence and to distinguish between (a) generalizations from given data that are not warranted beyond a reasonable doubt, and (b) generalizations which, although not absolutely certain or necessary, do seem to be warranted beyond a reasonable doubt.

Test 5. Evaluation of Arguments. (Fifteen items). Samples ability to distinguish between arguments which are strong and relevant and those which are weak or irrelevant to a particular question at issue.

Norms: Normative data are given for employed adults in executive and managerial occupations, college students, and students from grades 9 through 12. Norms for the secondary school are based on 20,312 students from 13 states.

Reliability: Reliability data, consisting of split-half internal consistency estimates, corrected by Spearman-Brown are acceptably high, ranging in the upper .80s for form YM and lower .80s for form ZM.

Validity: Validity data for the test come from the correlation of the test with other tests, from factor analytic studies and judgments on its content by other experts in the field.

The items of the Watson-Glaser Critical Thinking Appraisal represent an adequate sample of the five abilities set forth by the Cooperation Study of Evaluation in General Education. The five abilities are (Watson & Glaser, 1964, p. 10).

1. The ability to define a problem.
2. The ability to select pertinent information for the solution of a problem.
3. The ability to recognize stated and unstated assumptions.
4. The ability to formulate and select relevant and promising hypotheses.
5. The ability to draw conclusions validly and to judge the validity of inferences.

"The five subtests" according to Hill (1959, p. 796) "are clearly pertinent to most definitions of critical thinking."

The mention of factor-analytic study (Rust, Jones & Kaiser 1962) has already been made. Rust (1960) factor analyzed the items of the Watson-Glaser, the ACE Test of Critical Thinking and the Principles of Critical Thinking Test prepared by the Illinois Curriculum Program Committee for its Critical Thinking Project. Using Thurstone's centroid method, she found a weak general factor.

Correlations between the raw scores on the Watson-Glaser Critical Thinking Appraisal and other measures of

intelligence range from .55 to .75 (Watson-Glaser 1964, p. 10).

The Correlations of Watson-Glaser Critical Thinking Appraisal with other intelligence tests might be taken as evidence of concurrent validity, the factor analyses (Rust 1960; Rust, Jones & Kaiser 1962) which have been done may be classified as evidence of the test's construct validity. Studies by Dressel & Mayhew (1954); Guilford (1956); Hill (1959); Houle (1943); and Morse & McCune (1957) showing the resemblance and overlap of the views of Watson and Glaser on critical thinking with the others may be best classified as evaluation of the tests' content validity.

Hill (1959) considered the test to be of high quality (p. 797) and Hovland (1959) opined that the "test is a conscientous, imaginative effort to provide appraisal in a most difficult area (p. 797)." The test has been used by Bledsoe (1955), Hollenbach & De Graaf (1957) and O'Neill (1966) to mention only a few instances.

Otis-Lennon Mental Ability Test

The Otis-Lennon Mental Ability Test is the fourth revised edition in the Otis series. The first edition, published in 1918, was the first group test of mental ability. The series measures the general mental ability and not the innate mental capacity. The tests are available in two forms J & K, each with six levels: Primary I and II,

Elementary I and II, Intermediate and Advanced. The present study used Form J, Advanced level which is recommended for use with typical secondary school pupils.

Norms: The norms are based upon approximately 200,000 students from 117 school systems in 50 states (Otis-Lennon 1967, p. 23).

Reliability: Alternate-forms, split-half corrected by the Spearman-Brown formula, KR20 and test-retest reliabilities are .92, .95, .94, and .87 respectively (Otis-Lennon, 1967 pp. 20-21). Chissom & Thomas (1971) found the reliability coefficient of Primary I level using the split-half odd-even method to be .91 after it was corrected by the Spearman-Brown formula.

Validity: Correlation coefficients with Iowa Tests of Basic Skills, California Achievement Tests, Otis Quick-Scoring Mental Ability Tests, Lorge-Thorndike Intelligence Test, School and College Ability Test, Ohio Survey Test, SRA Primary Mental Abilities, Differential Aptitude Tests, The American College Testing Program Examination, and the National Merit Scholarship Qualifying Test cluster between .85 and .93 (Smith 1970, p. 92).

Test Anxiety Scale

The Test Anxiety Scale is one of the six scales of the Auto-biographical Survey (Sarason 1958a, 1958b). As the name indicates, the scale attempts to fathom the test

anxiety of the students. It consists of 21 statements to be answered true or false. Most of these statements are derived from items in the Test Anxiety Questionnaire used by Mandler and Sarason (1952). Sarason (1958a) report the test-retest reliability of Test Anxiety Scale to be above .78.

Experimental Procedure

The sample for the study consisted of all the students taking Mathematics 30 in a high school in Edmonton. Four teachers and six classes took part in the study. Two teachers taught two classes each and two teachers taught one class each. Before the experiment commenced, all the students were given the Otis-Lennon Mental Ability Test and the Test Anxiety scale developed by Sarason. All the students in a class were taught by the same teacher in the same classroom. Each teacher randomly divided a class into two groups for the purpose of giving quizzes. The students were not aware of any grouping. They were not separated in any way. One group was always given the higher level quizzes and the other always given lower level quizzes.

The quizzes were scored. The answer sheets were returned to the students but not the question booklets.

After covering Chapter I and giving all the quizzes based on that Chapter, all the quizzes that a student had taken were returned to him or her, to study in the classroom

for a day. The teacher did not discuss any question from any quiz in the classroom but answered individual questions posed by the students in his class. In fact, the students were asked to study on their own, not to discuss any question with one another and to discuss any difficulty they might have with the teacher. At this stage, all the students were given the Watson-Glaser Critical Thinking Appraisal. It was followed by Final Examination I the next day.

The students were told that the marks they received in the quizzes and in the final examination would determine their grade for the first report card.

Table 1

TOTAL NUMBER OF STUDENTS YIELDING COMPLETE DATA

Treatment	Male	Female	Total
Higher Level Quizzes	56	38	94
Lower Level Quizzes	57	39	96
	113	77	190

Variables

Sex, intelligence score as measured by Otis-Lennon Mental Ability Test, and test anxiety score as measured by the Test Anxiety Scale developed by Sarason were the independent variables in the study.

Scores on the following tests were the dependent

variables in the study.

(i) Watson-Glaser Critical Thinking Appraisal.

(ii) Lower Level questions of Final Examination I.

(iii) Higher Level questions of Final Examination I.

(iv) Lower Level questions of Final Examination II.

(v) Higher Level questions of Final Examination II.

CHAPTER IV

HYPOTHESES, RESEARCH DESIGN, ANALYSES, AND RESULTS

The central question in this study was whether the level of quizzes used by the teacher as part of teaching, had any relation with the learning performance and/or the critical thinking of the students. An attempt was also made to determine if sex, intelligence, and test anxiety were related to the performance of the students or to their critical thinking.

LEARNING PERFORMANCE

Hypotheses Related to Learning Performance and Level of Quizzes

Since the central question was one of levels of quizzes used by the teachers, hypotheses 1(a), 1(b), 1(c), and 1(d) below, were formulated to test if the level of quizzes had any relationship with the academic performance of the students.

Hypothesis 1(a)

There is no significant difference in the scores on the lower level questions of Final Examination I between the students who were always given the higher level quizzes and those who were always given the lower level quizzes.

Hypothesis 1(b)

There is no significant difference in the scores on higher level questions of Final Examination I between the

students who were always given the higher level quizzes and those who were always given the lower level quizzes.

The same hypotheses were repeated, using Final Examination II. i.e.,

Hypothesis 1(c)

There is no significant difference in the scores on the lower level questions of Final Examination II between the students who were always given the higher level quizzes and those who were always given the lower level quizzes.

Hypothesis 1(d)

There is no significant difference in the scores on the higher level questions of Final Examination II between the students who were always given the higher level quizzes and those who were always given the lower level quizzes.

It was decided to test hypotheses 1(a), and 1(b) first. If no significant difference was found, the same treatment was to be continued on the same group for an additional period of time. If a significant difference was observed, the groups were to be interchanged. This would lengthen the treatment period if no difference was observed and shorten the treatment period if a significant difference was observed. These differences in length would occur because before Final Examination I every student was given seven quizzes whereas after Final Examination I and before Final Examination II students were given three quizzes.

Hypotheses Related to Learning Performance and Sex

Is the sex of a student related to his or her learning performance? Can it be said that persons of one

sex differ significantly in their learning from those of the other sex? Hypothesis 2(a), 2(b), 2(c), and 2(d) were formulated in order to find answers to these important questions.

Hypothesis 2(a)

There is no significant difference in the scores on the lower level questions of Final Examination I between males and females who were given the same level of quizzes.

Hypothesis 2(b)

There is no significant difference in the scores on the higher level questions of Final Examination I between males and females who were given the same level of quizzes.

As in Hypothesis 1, the above two hypotheses were repeated using Final Examination II. i.e.,

Hypothesis 2(c)

There is no significant difference in the scores on the lower level questions of Final Examination II between males and females who were given the same level of quizzes.

Hypothesis 2(d)

There is no significant difference in the scores on the higher level questions of Final Examination II between males and females who were given the same level of quizzes.

Hypotheses Related to Learning Performance and Intelligence

Hypothesis 3(a)

There is no significant difference in the scores on the lower level questions of Final Examination I among high, medium and low intelligence students who were given the same level of quizzes.

Hypothesis 3(b)

There is no significant difference in the scores on the higher level questions of Final Examination I among high, medium and low intelligence students who were given the same level of quizzes.

Hypothesis 3(c)

There is no significant difference in the scores on the lower level questions of Final Examination II among high, medium and low intelligence students who were given the same level of quizzes.

Hypothesis 3(d)

There is no significant difference in the scores on the higher level questions of Final Examination II among high, medium and low intelligence students who were given the same level of quizzes.

The main purpose of hypotheses 3(a), 3(b), 3(c), and 3(d) was to see whether there is a relationship between intelligence and learning performance.

Research Design

To test the above hypotheses, analysis of variance was performed, using the scores on (a) lower level questions of Final Examination I, (b) higher level questions of Final Examination I, (c) lower level questions of Final Examination II and (d) higher level questions of Final Examination II, respectively. Tables 2, 3, 4, and 5 give the results of these analyses. The three factors in the design were Treatment, Sex, and Intelligence and the scores on the quizzes were used as the criterion measures.

Results

Tables 2, 3, 4, and 5 reveal that the following hypotheses were rejected:

1(d) see Table 5

2(b) see Table 3

3(a) see Table 2

3(b) see Table 3

3(c) see Table 4

3(d) see Table 5

None of the other hypotheses was rejected.

Rejection of hypothesis 1(d), and a comparison of means (see Table 6) indicated that in the higher level questions of Final Examination II, the mean score of the students who were given higher level quizzes was significantly higher than that of the students who were given lower level quizzes. In other words, the students who were given the higher level quizzes performed significantly better in the higher level questions than those who were given the lower level quizzes. The difference was observed only after the treatment had been in effect for the complete duration of the experiment - a period of seven weeks.

Rejection of hypothesis 2(b), followed by a comparison of the means (see Table 7) showed that males performed significantly better than females on the higher level questions in Final Examination I. The corresponding difference on Final Examination II, though in favor of the

Table 2

ANALYSIS OF VARIANCE (TREATMENT X SEX X INTELLIGENCE) OF THE SCORES ON THE LOWER LEVEL QUESTIONS OF FINAL EXAMINATION I

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	2.103	2.103	0.312	0.577
Sex	1	4.646	4.646	0.688	0.408
Treatment x Sex	1	10.612	10.612	1.572	0.212
Intelligence	2	64.082	32.041	4.748	0.010*
Sex x Intelligence	2	8.930	4.465	0.662	0.517
Treatment x Intelligence	2	12.553	6.277	0.930	0.395
Treatment x Sex x Intelligence	2	7.346	3.673	0.544	0.581
Error	178	1201.26	6.749		

*Significant at $\alpha = .05$

Table 3

ANALYSIS OF VARIANCE (TREATMENT X SEX X INTELLIGENCE) OF THE SCORES ON THE HIGHER LEVEL QUESTIONS OF FINAL EXAMINATION I

Source	df	Sum of Squares	Mean Square	F	P
Treatment	1	13.984	13.984	11.414	0.236
Sex	1	45.231	45.231	4.572	0.034*
Treatment x Sex	1	24.758	24.758	2.503	0.115
Intelligence	2	179.241	89.620	9.059	0.0001**
Sex x Intelligence	2	7.623	3.812	0.385	0.681
Treatment x Intelligence	2	13.770	6.885	0.696	0.500
Treatment x Sex x Intelligence	2	21.937	10.968	1.109	0.332
Errors	178	1760.96	9.893		

*Significant at $\alpha = 0.05$ ** Significant at $\alpha = .01$

Table 4

ANALYSIS OF VARIANCE (TREATMENT X SEX X INTELLIGENCE) OF THE SCORES ON THE LOWER LEVEL QUESTIONS OF FINAL EXAMINATION II

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	11.545	11.545	3.568	0.061
Sex	1	0.188	0.188	0.058	0.810
Treatment x Sex	1	3.330	3.330	1.029	0.312
Intelligence	2	45.686	22.843	7.060	0.001**
Sex x Intelligence	2	1.049	0.525	0.162	0.851
Treatment x Intelligence	2	5.290	2.645	0.818	0.443
Treatment x Sex x Intelligence	2	5.225	2.613	0.807	0.448
Errors	178	575.945	3.236		

**Significant at $\alpha = 0.01$

Table 5

ANALYSIS OF VARIANCE (TREATMENT X SEX X INTELLIGENCE) OF THE SCORES ON THE HIGHER LEVEL QUESTIONS OF FINAL EXAMINATION II

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	9.258	9.258	5.189	0.024*
Sex	1	5.881	5.881	3.297	0.071
Treatment x Sex	1	4.833	4.833	2.701	0.102
Intelligence	2	19.496	9.748	5.464	0.005**
Sex x Intelligence	2	4.796	2.398	1.344	0.263
Treatment x Intelligence	2	3.932	1.966	1.102	0.334
Treatment x Sex x Intelligence	2	1.572	0.786	0.440	0.644
Errors	178	317.553	1.784		

*Significant at $\alpha = 0.05$ ** Significant at $\alpha = .01$

Table 6

MEANS OF THE HIGH, MEDIUM AND LOW INTELLIGENCE STUDENTS IN THE HIGHER AND LOWER LEVEL QUESTIONS OF FINAL EXAMINATION I AND FINAL EXAMINATION II

	Means		
	High Intelligence	Medium Intelligence	Low Intelligence
Final Examination I			
Higher Level Questions	10.76	10.35	7.98
Final Examination I			
Lower Level Questions	7.56	7.37	5.96
Final Examination II			
Higher Level Questions	6.12	5.60	4.56
Final Examination II			
Lower Level Questions	4.32	4.07	3.41

Table 7

MEANS OF THE MALES AND THE FEMALES IN THE HIGHER AND LOWER LEVEL QUESTIONS OF FINAL EXAMINATION I AND FINAL EXAMINATION II

	Means	
	Males	Females
Final Examination I Higher Level Questions	10.36	9.07
Final Examination I Lower Level Questions	7.33	6.67
Final Examination II Higher Level Questions	5.54	5.27
Final Examination II Lower Level Questions	4.07	3.88

males, approached but failed to reach significance. There is, therefore, inconclusive evidence that males performed better on higher level questions.

Rejection of hypotheses 3(a), 3(b), 3(c), and 3(d) indicated, not surprisingly, that intelligence was related to learning performance. Scheffé's procedure for making comparisons was applied, and it was found that for all four hypotheses there was no significant difference in achievement scores between the high and medium intelligence groups. However, in all four cases the differences were significant between the low intelligence group and the medium intelligence group on the one hand, and between the low intelligence group and the high intelligence group on the other.

In summary, there was no significant difference in the learning performance between the high and medium intelligence students but the learning performance of the low intelligence students was significantly different from that of the high as well as the medium intelligence groups.

CRITICAL THINKING

Hypothesis Related to Critical Thinking and Level of Quizzes

Is there any difference in the critical thinking of the students who were given higher level quizzes from those given the lower level questions? The Watson-Glaser Critical Thinking Appraisal was administered to all the students

in the study to assist in finding an answer to this question.

Hypothesis 4

There is no significant difference in the scores on the Watson-Glaser Critical Thinking Appraisal between the students who were given the higher level quizzes and those who were given the lower level quizzes.

Hypothesis Related to Critical Thinking and Sex

Hypothesis 5

There is no significant difference in the scores on the Watson-Glaser Critical Thinking Appraisal between males and females who were given the same level of quizzes.

Hypothesis Related to Critical Thinking and Intelligence

Hypothesis 6

There is no significant difference in the scores on the Watson-Glaser Critical Thinking Appraisal among the high, medium and low intelligence students.

Research Design

To test hypotheses 4, 5, and 6, a Treatment X Sex X Intelligence (2X2X3) analysis of variance was done, using the scores on the Watson-Glaser Critical Thinking Appraisal. Table 8 gives the results obtained.

Results

Hypotheses 4, 5, and 6 were rejected. This means that the level of quizzes, the sex and the intelligence level of the students are all related to scores on critical

thinking as measured by the Watson-Glaser Critical Thinking Appraisal.

The students who were given higher level quizzes scored significantly higher on the Watson-Glaser instrument than those given lower level quizzes. The means of the two groups were 58.07 and 54.36 respectively.

Males did significantly better than females, with means of 57.75 and 55.25 respectively.

The high, medium and low intelligence students differed significantly from one another. The means were 66.12, 56.14 and 50.89 respectively.

TEST ANXIETY

Hypotheses Related to Test Anxiety and Learning Performance

Is test anxiety related to learning performance of the students? This question is important because it is possible that test anxiety is a confounding variable affecting scores. The hypotheses set forth below were formululated to answer the question.

Hypothesis 7(a)

There is no significant difference in the scores on the lower level questions of Final Examination I among the high, medium and low test anxiety students.

Hypothesis 7(b)

There is no significant difference in the scores on the higher level questions of Final Examination I among

Table 8

ANALYSIS OF VARIANCE (TREATMENT X SEX X INTELLIGENCE) OF THE SCORES OF THE WATSON GLASER CRITICAL THINKING APPRAISAL

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	609.588	609.588	6.353	0.013*
Sex	1	380.060	380.060	3.961	0.048*
Treatment x Sex	1	4.516	4.516	0.047	0.829
Intelligence	2	3598.45	1799.23	18.750	0.000**
Sex x Intelligence	2	78.634	39.317	0.410	0.664
Treatment x Intelligence	2	162.779	81.390	0.848	0.430
Treatment x Sex x Intelligence	2	121.364	60.682	0.632	0.533
Errors	178	17080.2	95.957		

*Significant at $\alpha = 0.05$ ** Significant at $\alpha = .01$

high, medium and low test anxiety students.

Hypothesis 7(c)

There is no significant difference in the scores on the lower level questions of Final Examination II among high, medium and low test anxiety students.

Hypothesis 7(d)

There is no significant difference in the scores on the higher level questions of Final Examination II among the high, medium and low test anxiety students.

Hypothesis Related to Test Anxiety and Critical Thinking

Hypothesis 8

There is no significant difference in the scores on the Watson-Glaser Critical Thinking Appraisal among the high, medium and low test anxiety students.

Research Design

To test hypotheses 7 and 8, a Treatment X Sex X Anxiety (2X2X3) analyses of variance was performed repeatedly, using scores on the lower level questions of Final Examination I, higher level questions of Final Examination I, lower level questions of Final Examination II, higher level questions of Final Examination II, and the scores on the Watson-Glaser Critical Thinking Appraisal. Tables 9, 10, 11, 12, and 13 give these analyses respectively.

Results

Hypotheses 7(a), 7(b), 7(c), and 7(d) were all accepted (see Tables 9, 10, 11, and 12) indicating that

no relationship was found between test anxiety and learning performance on all the four mathematics examinations.

Hypothesis 8 was rejected at the .05 level (see Table 13), that is, test anxiety scores were found to be related to critical thinking scores. Means of 54.31, 55.82, and 60.83 occurred on the Watson-Glaser Critical Thinking Appraisal for the high, medium, and low test anxiety groups. Scheffé's test was again used to test for the difference. It was found that the mean critical thinking score for the low test anxiety group was significantly higher than the mean for either the medium or high test anxiety groups.

Comparison of Complexity and Difficulty

Final Examination I was composed of 13 Knowledge, 7 Comprehension, 7 Application, and 6 Analysis questions. Final Examination I can, therefore, be considered to consist of four subtests. Scores on these subtests were calculated and then analysed with a view to determining whether a hierarchy was present.

Guttman's simplex theory (Guttman, 1954) is fundamentally concerned with studying the orders of complexity and Kaiser (1962) suggested the method for finding the optimum simplex arrangement.

Guttman (1954) used partial correlation to define ordering of variables along a dimension of complexity. According to him, variable Z will be intermediate in complexity to variables X and Y if the partial correlation

Table 9

ANALYSIS OF VARIANCE (TREATMENT X SEX X ANXIETY) OF THE SCORES ON THE LOWER LEVEL QUESTIONS OF FINAL EXAMINATION I

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	0.549	0.549	0.077	0.782
Sex	1	17.909	17.909	2.506	0.115
Treatment x Sex	1	12.645	12.645	1.769	0.185
Anxiety	2	19.593	9.797	1.371	0.257
Sex x Anxiety	2	1.266	0.633	0.089	0.915
Treatment x Anxiety	2	0.056	0.028	0.004	0.996
Treatment x Sex x Anxiety	2	2.003	1.002	0.140	0.869
Errors	178	1271.98	7.146		

Table 10

ANALYSIS OF VARIANCE (TREATMENT X SEX X ANXIETY) OF THE SCORES ON THE HIGHER LEVEL QUESTIONS OF FINAL EXAMINATION I

Source	df	Sum of Squares	Mean Square	F	P
Treatment	1	3.632	3.632	0.339	0.561
Sex	1	96.300	96.300	9.000	0.003**
Treatment x Sex	1	28.049	28.049	2.621	0.107
Anxiety	2	20.470	10.235	0.957	0.386
Sex x Anxiety	2	22.766	11.383	1.064	0.347
Treatment x Anxiety	2	0.104	0.052	0.005	0.995
Treatment x Sex x Anxiety	2	40.446	20.223	1.890	0.154
Errors	178	1904.55	10.700		

**Significant at $\alpha = 0.01$

Table 11

ANALYSIS OF VARIANCE (TREATMENT X SEX X ANXIETY) OF THE SCORES ON THE LOWER LEVEL QUESTIONS OF FINAL EXAMINATION II

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	4.095	4.095	2.189	0.141
Sex	1	0.335	0.335	0.179	0.673
Treatment x Sex	1	4.783	4.783	2.556	0.112
Anxiety	2	3.452	1.726	0.923	0.399
Sex x Anxiety	2	7.742	3.871	2.069	0.129
Treatment x Anxiety	2	0.927	0.464	0.248	0.781
Treatment x Sex x Anxiety	2	4.716	2.358	1.260	0.286
Errors	178	333.076	1.871		

Table 12

ANALYSIS OF VARIANCE (TREATMENT X SEX X ANXIETY) OF THE SCORES ON THE HIGHER LEVEL QUESTIONS OF FINAL EXAMINATION II

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	13.804	13.804	4.027	0.046*
Sex	1	5.707	5.707	1.665	0.199
Treatment x Sex	1	1.576	1.576	0.460	0.499
Anxiety	2	7.898	3.949	1.152	0.318
Sex x Anxiety	2	1.348	0.674	0.197	0.822
Treatment x Anxiety	2	16.192	8.096	2.362	0.097
Treatment x Sex x Anxiety	2	2.130	1.065	0.311	0.733
Errors	178	610.129	3.428		

*Significant at $\alpha = 0.05$

Table 13

ANALYSIS OF VARIANCE (TREATMENT X SEX X ANXIETY) OF THE SCORES ON WATSON GLASER CRITICAL THINKING APPRAISAL

Source	df	Sum of Squares	Mean Square	F	p
Treatment	1	307.497	307.497	2.767	0.098
Sex	1	58.306	58.306	0.525	0.470
Treatment x Sex	1	62.258	62.258	0.560	0.455
Anxiety	2	742.879	371.440	3.342	0.038*
Sex x Anxiety	2	188.166	94.083	0.847	0.431
Treatment x Anxiety	2	314.595	157.298	1.415	0.246
Treatment x Sex x Anxiety	2	271.324	135.662	1.221	0.297
Errors	178	19781.1	111.130		

*Significant at $\alpha = 0.05$

between X and Y is zero when Z is partialed out, i.e., $r_{XY \cdot Z} = 0$.

It is not common to get a perfect simplex from a set of data obtained from a research. However, such data may form a quasi-simplex. In the correlation matrix of such a set of tests, the correlation coefficients between the tests taper off in all directions from the diagonal, i.e., the largest coefficients occur next to the main diagonal and they go on decreasing as they recede from the main diagonal.

As mentioned earlier, Final Examination I was composed of four subtests. The intercorrelations of these tests were determined as a first step to find if a simplex arrangement existed. Table 14 gives these intercorrelations. The largest coefficients are near the main diagonal and, with a few minor exceptions, taper off in all directions from the main diagonal. This means the complexity of the tests increases from Knowledge to Analysis. The Knowledge questions are the least complex and the Analysis questions are the most. A quasi-simplex, therefore, was inferred to be present.

The analysis of Final Examination I supplied evidence that there were, indeed, four thought process levels represented, and that they were in the expected order of complexity.

The difficulty of each test was obtained by dividing the sum of scores on the test by the number of questions in the test and multiplying the quotient

Table 14

INTERCORRELATIONS (PEARSON PRODUCT-MOMENT) OF KNOWLEDGE, COMPREHENSION, APPLICATION, AND ANALYSIS SUBTESTS

Test	Knowledge	Comprehension	Application	Analysis
Knowledge	1.000	0.623	0.467	0.379
Comprehension	0.623	1.000	0.438	0.304
Application	0.467	0.438	1.000	0.402
Analysis	0.369	0.304	0.402	1.000

by 100. The difficulty levels of the Knowledge, Comprehension, Application, and Analysis subtests were 54.41, 56.31, 48.04 and 42.98 respectively. To test for the significance of differences between these difficulties, one way analysis of variance, with repeated measures, was performed after converting the scores of each student in each subtest to a percentage. Table 15 gives a summary of the results. According to this table, the null hypothesis of no difference in the difficulties of the sbutests was rejected. Tukey's HSD test was performed using Mean Square Residual & Mean Square Error with $\alpha = .05$. This showed that with the exception of Knowledge and Comprehension subtests, the difficulties of all the other tests were significantly different from one another.

Thus, in order of increasing complexity, the tests can be arranged as

(Knowledge) (Comprehension) (Application) (Analysis)

and according to increasing difficulty:

(Knowledge)
(Comprehension) (Application) (Analysis)

The order of difficulties seems similar to the order of complexity.

Table 15

ANALYSIS OF VARIANCE OF THE PERCENTAGES OF THE STUDENTS IN KNOWLEDGE, COMPREHENSION, APPLICATION AND ANALYSIS SUBTESTS

Source	df	Sum of Squares	Mean Square	F
Between Students	189	198613.00	1050.86	
Within Students	570	167103.00	293.16	
Tests	3	21167.00	7055.66	27.41
Residual	567	145936.00	257.38	
Total	759	365716.00		

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

SUMMARY

Level of Quizzes and Learning Performance

There is no significant difference in the scores of the lower level questions between the students who were given the higher level quizzes, and the students who were given the lower level quizzes. However, the students who were given higher level quizzes performed significantly better in the higher level questions than the students who were given the lower level quizzes. The difference was observed after the students had taken the quizzes for a certain length of time, that is, after the treatment had been prolonged.

Sex and Learning Performance

Males performed significantly better than females on the higher level questions, on the lower level questions, however, there was no significant difference.

Intelligence and Learning Performance

Intelligence did make a difference in the learning performance of both male and female students. High intelligence students performed significantly better than the low intelligence students on both the higher and lower

level questions. However, a significant difference was not observed between the high and medium intelligence students in this respect.

Level of Quizzes and Critical Thinking

The students who were given higher level quizzes scored significantly higher in the Watson-Glaser Critical Thinking Appraisal than the students who were given the lower level quizzes.

Sex and Critical Thinking

Males did significantly better than females in the Watson-Glaser Critical Thinking Appraisal.

Intelligence and Critical Thinking

High, medium and low intelligence students differed significantly in the critical thinking ability as measured by Watson-Glaser Critical Thinking Appraisal. The critical thinking ability was higher as intelligence increased.

Test Anxiety and Learning Performance

Test anxiety did not influence learning performance.

Test Anxiety and Critical Thinking

The low test anxiety students did significantly better than medium and high test anxiety students on the Watson-Glaser Critical Thinking Appraisal. There was no significant difference between the medium and the high test anxiety students.

Complexity and Difficulty

The order of difficulties seemed very much the same as that of complexity.

CONCLUSIONS AND IMPLICATIONS

The results of this study indicate that the higher level quizzes help both the male and female students in the performance in Mathematics and that the students who were given higher level quizzes performed significantly better on the Watson-Glaser Critical Thinking Appraisal. These findings agree with the views of Aschner (1961), Bloom (1953), Bradley (1966), Carner (1963), Ebel (1969), Link (1963), Lombard (1965), Miller (1966), Pfeiffer & Davis (1965) and Van Til (1961) in recognizing the importance of questions as a means of stimulating and developing thinking ability. Thus the results imply that teachers should pay attention to the level of questions used by them and should make every endeavour to construct higher level, thought provoking questions. It should be pointed out, however, that in this study, and in those listed above, the evidence is not conclusive that the difference in achievement was not caused by more difficult questions as opposed to more cognitively complex questions.

It is noted that test anxiety level did not make any difference in the learning performance, but it did make a difference in the critical thinking ability. Low test anxiety students performed significantly better on the

Watson-Glaser Critical Thinking Appraisal than those with medium and high test anxiety. The findings tend to support Bloom (1953) who found that most anxious subjects did as well as others on questions requiring specific information and familiar material, but relatively poorly on interrelating familiar material and on applying it to new situations.

It came as no suprise to note that intelligence did influence the learning performance of the students. In fact, Wrigley (1958), after reviewing literature, found general agreement that the most important factor for success in mathematics was the general intelligence factor.

Is is also worth mentioning that this study supported the hierarchical structure of Bloom's Taxonomy.

SUGGESTIONS FOR FURTHER RESEARCH

It would be interesting and informative to do similar studies with Physics, Chemistry, Biology, and Social Sciences or using students at some other grade levels.

A study dealing with the comparison of complexity and difficulty is very strongly recommended. In planning such a study, the first step should be making a set of difficult questions at lower level so that the order of difficulties in the test should be other than the order of the levels of the Taxonomy. The number of questions at each level should definitely be more than that used in this study.

Instead of using teachers, computers can be used to teach students or self-instructional material can be used.

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APPENDICES

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Content of Chapter I. Secondary School Mathematics Grade Twelve by W. B. MacLean W. L. Alexander and D. W. Beesack

CONTENT OF CHAPTER I

SECONDARY SCHOOL MATHEMATICS GRADE TWELVE

Real Numbers, Real Functions

Real numbers

Number system; field; group

Relations

Functions; mapping

Inverse function

The general linear function

General quadratic function and quadratic equation

Graphs of functions of higher degree

A2

Content of Chapter 1V. Secondary School Mathematics Grade Twelve by W. B. MacLean W. L. Alexander and D. W. Beesack

CONTENT OF CHAPTER IV

SECONDARY SCHOOL MATHEMATICS GRADE TWELVE

Complex Numbers

Introduction

Complex numbers

Desirable properties for the complex numbers

Equality in C

Addition and subtraction in C

Multiplication in C

Division in C; inverse elements for multiplication

The real numbers as a subset of C

Geometric representation of complex numbers

The modulus or absolute value of a complex number

The distance between two points in the complex plane

Summary

Quadratic equations in C if a, b, c $\in$ R; the quadratic formula

A3

Content of Chapter V. Secondary School Mathematics Grade Twelve by W. B. MacLean W. L. Alexander and D. W. Beesack

CONTENT OF CHAPTER V

SECONDARY SCHOOL MATHEMATICS GRADE TWELVE

Quadratic Relations

Quadratic relations

The standard form of the equation of the circle

The general equation of the circle

The parabola; vertex the origin, and axis of symmetry the x-axis

The focus, directrix definition of a parabola

The standard form of the equation of a parabola

The parabola defined by $y^2 = bx + c$, $b, c \neq 0$, $x, y, b, c \in R$

The ellipse; centre the origin, axes of symmetry the x-axis and y-axis

The constant sum definition of an ellipse

The standard form of the equation of an ellipse

The hyperbola; centre the origin, axes of symmetry the x-axis and y-axis

The constant difference definition of a hyperbola

The standard form of the equation of a hyperbola

A method of sketching a hyperbola

Asymptotes of a hyperbola

Pairs of straight lines

Linear-quadratic systems

B1

Lower Level Quizzes Set I

Mathematics 30

This is 20 minutes test. It contains 10 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. "a + b = b + a, a, b $\in$R" This is known as

   A. Closure property of addition
   B. Associative property of addition
   C. Distributive property
   D. Commulative property of addition

2. $(a \cdot b)^n = a^n b^n$, a,b$\in$R, the verbal name of this law of exponent is

   A. Power of a quotient
   B. Power of a product
   C. Law of quotient
   D. Negative exponent

3. The value of $(a)^0$ is

   A. 1
   B. 0
   C. a
   D. none of these

4. If 64 is expressed as 2^6, the 2 in 2^6 is called the

   A. Logarithm
   B. Power
   C. Base
   D. Exponential

5. "If a$>$b and b$>$c, then a$>$c, a,b,c $\in$R" is known as

   A. Associative property
   B. Transitive property
   C. Trichotomy property
   D. Reflexsive property

6. The identity element for addition is

   A. 0
   B. 1
   C. 1 and 0
   D. -1

7. a $\in$R, a = a, This is known as

   A. Symmetric property
   B. Replacement property
   C. Reflexive property
   D. Transitive property

8. The additive inverse of a is

A. 0
B. -a
C. a
D. $\frac{1}{a}$

9. $a \neq 0$, $a,n \in R$, a^{-n} is equal to

A. $\frac{1}{a^n}$

B. $\frac{1}{an}$

C. $\frac{a}{n}$

D. none of these

10. $a^m \times a^n =$, $a \neq 0$, $m,n \in I$.

A. a^{mn}

B. $a^m + a^n$

C. $(2a)^{m+n}$

D. a^{m+n}

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1. In $\sqrt[3]{64}$, 3 is called.

   A. radical
   B. power
   C. index
   D. exponent

2. If set A contains m elements and set B contains n elements, then the number of elements in the cross product A x B is

   A. $\frac{m}{n}$
   B. m^2
   C. $m + n$
   D. mn

3. If $\oplus$ is addition modulo 5, then the identity element for the operation $\oplus$ is

$\oplus$	0	1	2	3	4
0	0	1	2	3	4
1	1	2	3	4	0
2	2	3	4	0	1
3	3	4	0	1	2
4	4	0	1	2	3

   A. 0
   B. 1
   C. 2
   D. 3

4. Expressed in the entire radical form $3\sqrt{4}$ become

   A. $\sqrt{3^2 \times 4}$
   B. $\sqrt{3 \times 4}$
   C. $\sqrt{3 \times 4^2}$
   D. $\sqrt{3^2 \times 4^2}$

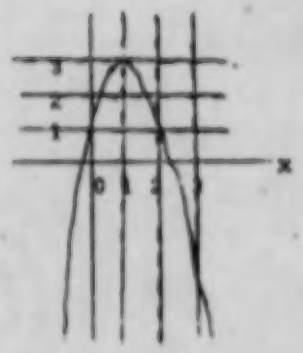
5. $\sqrt{x} \cdot \sqrt{y}$ is equal to

   A. $\sqrt{xy}$
   B. $\sqrt{x + y}$
   C. $\sqrt{x^2y^2}$
   D. None of these

6. One of the steps in finding the x-intercept(s) of a relation is

   A. Put x=0 in the defining equation of the relation
   B. Put y=0 in the defining equation of the relation
   C. Put x=x in the defining equation of the relation
   D. Put y=x in the defining equation of the relation

7. The range of the graph is



A. { y| y=3, y∈R }
B. { y| y<3, y∈R }
C. { y| y≥3, y∈R }
D. { y| y≥3, y∈R }

8. In $\sqrt[c]{D}$ "D" is called

A. radical
B. index
C. variable
D. radicand

9. $\sqrt{a} + \sqrt{b}$ is equal to

A. $\sqrt{a+b}$
B. $\sqrt{ab}$
C. a+b
D. None of these

10. The defining equation of the ralation

$P=\{(x,y) \mid 2x-y+3=0,\ x,y\in R\}$

in the standard form is

A. y = -2x-3
B. y = 2x-3
C. y = -2x+3
D. y = 2x+3

Mathematics 30

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1. Definition of function is:

   A. A relation in which each element of the domain is associated with at least one element of the range.
   B. A relation in which each element of the domain is associated with one and only one element of the range.
   C. A relation in which each element of the range is associated with at least one element of the domain.
   D. A relation in which each element of the range is associated with one and only one element of the domain.

2. The graphs of a function and its inverse function are always symmetrical

   A. with respect to the origin
   B. with respect to the x-axis
   C. with respect to the y-axis
   D. about the line $y=x$

3. In the illustrations below the elements of the domain are associated with the elements of the range. The arrows are drawn from the points representing elements of the domain to the points representing elements of the range. Which of the association is one-to-one function

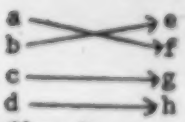

fig. 1

fig. 2

fig. 3

fig. 4

   A. fig. 1
   B. fig. 2
   C. fig. 3
   D. fig. 4

4. Name the notation in which the function g is represented
   $g:x \rightarrow 3x+1,\ x \in I$

   A. set-builder
   B. mapping
   C. image
   D. inverse

5. The domain of the inverse of a function is

   A. the same as the domain of the function
   B. obtained by replacing each element of the domain of function by its multiplicative inverse
   C. the same as the range of the function
   D. obtained by replacing each element of the range of the function by its multiplicative inverse

6. If a function f is expressed in the set-builder notation and the domain is the set of real numbers then the inverse function of f, if any, is obtained by

   A. interchanging the variables in the defining equation of the function
   B. replacing the variables in the defining equation of the function by their reciprocals
   C. changing the signs of the variables in the defining equation of the function.
   D. replacing f by f^{-1}

7. If a function is given in the set-builder notation then

   A. it cannot be expressed in any other notation
   B. it can be expressed only in the image notation
   C. it can be expressed only in the mapping notation
   D. it can be expressed in both the image and the mapping notation

8. Which function f, g, or h is expressed in the image notation

   $f=\{(x,y) \mid y=2x+5,\ x\in R\}$

   $g: x \to 2x+1, x\in I$

   $h(r)=5r+2, r\in R$

   A. f
   B. g
   C. h
   D. none of these

9. If the set of ordered pairs of the function h are given then the set of ordered pairs of h^{-1} is obtained by

   A. interchanging the members af at least one ordered pair
   B. interchanging the members of one of the ordered pairs
   C. interchanging the members of each ordered pair
   D. changing the order of the ordered pairs

10. The *vertical line test* of a function is stated as:

A. A relation is a function if and only if one vertical line intersects the graph of the relation in more than one point.
B. A relation is a function if no vertical line intersects the graph of the relation in more than one point.
C. A relation is a function if at least one vertical line can be drawn not cutting the graph of the relation
D. A relation is a function if its graph is not a vertical line

Mathematics 30

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If a quadratic function is defined by $y = ax^2+bx+c$ then answer question 1 to 5.

1. The axis of symmetry of the graph is

   A. $x = \frac{-2a}{b}$

   B. $x = \frac{-b}{2a}$

   C. $x = \frac{-b}{a}$

   D. $x = \frac{b}{2a}$

2. The maximum or the minimum value is given by

   A. $\frac{b^2 - 4ac}{2a}$

   B. $\frac{4ac - b^2}{2a}$

   C. $\frac{b^2 - 4ac}{4a}$

   D. $\frac{4ac - b^2}{4a}$

3. If $a>0$ then the graph always

   A. opens downward

   B. opens upward

   C. passes through the origin

   D. touches the x-axis

4. If we know that we can find the minimum value of the function, then the value of x that will make the function minimum is

   A. $\frac{-b}{2a}$

   B. $\frac{-b}{a}$

   C. $\frac{b}{2a}$

   D. $\frac{4ac - b^2}{4a}$

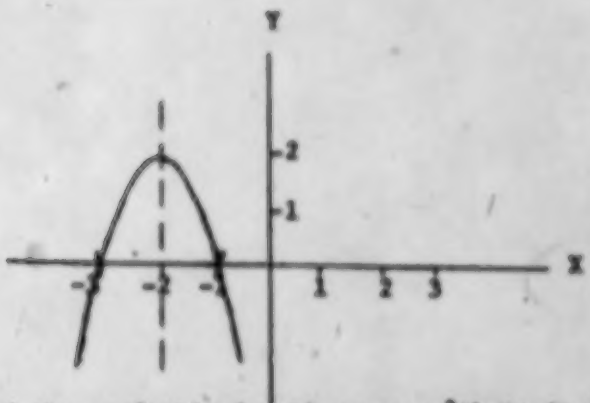
5. The best known name of the graph is

   A. a curved line

   B. two st. lines

   C. hyperbola

   D. parabola



The graph of the quadratic function $y = ax^2+bx+c$ is depicted as in the sketch above , answer question 6 - 10.

6. It is known that

   A. $a = o$

   B. $a > o$

   C. $a < o$

   D. $b^2-4ac \geq o$

7. The maximum value of the function is

   A. 2

   B. -2

   C. -3

   D. -1

8. The value of x for which y is maximum is

   A. -3

   B. -1

   C. 2

   D. -2

9. The equation of the axis of symmetry of the graph is

   A. $x = 2$

   B. $x + 2 = 0$

   C. $x - 2 = 0$

   D. $x = -1$

10. The vertex of the graph is

   A. (-2, -2)

   B. (2, -2)

   C. (-2, 2)

   D. (-1, -3)

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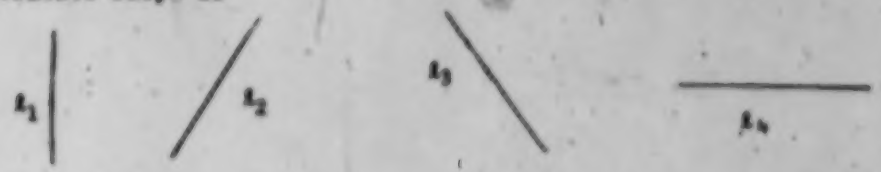
1. ℓ_1, ℓ_2, ℓ_3 and ℓ_4 are the lines drawn below. The line with positive slope is



A. ℓ_1
B. ℓ_2
C. ℓ_3
D. ℓ_4

2. The y-coordinate of a point is called

A. abscissa
B. coodinate
C. ordered pair
D. ordinate

3. The equation of a line with slope m and y-intercept b is

A. $y = mx + b$
B. $y = bx + m$
C. $y = mx - b$
D. $y = m(x-b)$

4. The equation of a line parallel to x - axis and on $P(x_1, y_1)$ is

A. $x = x_1$
B. $y = y_1$
C. $y = x_1$
D. $x = y_1$

5. If m is the slope of the line on $P(x_2, y_2)$ then the equation of the line is

A. $y-y_1=m(x-x_1)$
B. $y=m(x-x_1)$
C. $y_1-y_2=m(x_1-x_2)$
D. $y-y_2=m(x-x_2)$

6. The general expression for the coordinates of the mid-point of the line segment determined by $P_1(x_1,y_1)$ and $P_2(x_2,y_2)$ is

A. $\left(\frac{x_1+y_1}{2}, \frac{x_2+y_2}{2}\right)$

B. $\left(\frac{x_2-x_1}{2}, \frac{y_2-y_1}{2}\right)$

C. $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$

D. $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

7. $P(x_1,y_1)$ and $S(x_2,y_2)$ are two points on a line the slope of the line is

   A. $\frac{x_2-x_1}{y_2-y_1}$

   B. $\frac{y_2+y_1}{x_2+x_1}$

   C. $\frac{y_1-y_2}{x_1-x_2}$

   D. $\frac{x_2+x_1}{y_2+y_1}$

8. If a line with slope m, is parallel to a line with slope m_2 then

   A. $m_1=-m_2$
   B. $m_1=m_2$
   C. $m_1 \times m_2 = -1$
   D. $m_1 \times m_2 = 1$

9. $y = mx + 7$ is the equation of a family of line. In such an equation the name that is given to m is

   A. Constant
   B. Variable
   C. Perimeter
   D. None of these

10. The length of the perpendicular from $P(x_1,y_2)$ to the line $Ax + By + C = 0$ is given by

   A. $\frac{Ax_1+By_1+C}{\sqrt{A^2+C^2}}$

   B. $\frac{|Ax_1+By_1+C|}{\sqrt{A^2+B^2}}$

   C. $\left|\frac{Ax_1+By_1+C}{A^2+B^2}\right|$

   D. $\frac{|Ax_1+By+C|}{\sqrt{A^2+B^2+C^2}}$

Mathematics 30

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1. The sum of the roots of the general quadratic equation $ax^2+bx+c=0$, $a,b,c \in R$ is given by

   A. $\frac{-b}{2a}$

   B. $-\frac{a}{b}$

   C. $\frac{-b}{a}$

   D. $\frac{b}{a}$

2. The discriminant of the quadratic equation $ax^2+bx+c=0$ is

   A. b^2-4ac

   B. $\sqrt{b^2-4ac}$

   C. $4ac-b^2$

   D. $\frac{4ac-b^2}{2a}$

3. If the quadratic equation $ax^2+bx+c=0$ has two real and unequal roots then

   A. $4ac-b^2>0$

   B. $b^2-4ac>0$

   C. $b^2-4ac<0$

   D. $b^2-4ac\geq 0$

4. The formula to find the roots of the quadratic equation $ax^2+bx+c=0$ is

   A. $\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

   B. $-b\pm\frac{\sqrt{b^2-4ac}}{2a}$

   C. $\frac{-b\pm\sqrt{4ac-b^2}}{2a}$

   D. $-b\pm\frac{\sqrt{4ac-b^2}}{2a}$

5. If a quadratic equation has real roots then the discriminant is

   A. greater than zero

   B. greater than or equal to zero

   C. less than zero

   D. less than or equal to zero

6. If a quadratic equation in x has two real and equal roots then the graph of the corresponding quadratic function will

   A. open upward

   B. cut the x-axis

   C. open downward

   D. touch the x-axis

7. If 'S' represents the sum and 'P' represents the product of the roots then the quadratic equation is formed by using the formula

   A. $x^2-Sx+P=0$

   B. $x^2+Sx-P=0$

   C. $x^2+Sx+P=0$

   D. $x^2+Px-S=0$

8. To solve a quadratic equation in x graphically

   A. One draws the graph of the quadratic equation and finds the x-intercept(s)

   B. One draws the graph of the corresponding quadratic function and finds the x-intercept(s)

   C. One draws the graph of the quadratic equation and finds the x-intercept(s) and y-intercept(s)

   D. One draws the graph of the quadratic function and finds the y-intercept(s)

9. $ax^2+bx+c=0$ $a,b,c \in R$ always represents a quadratic equation on the condition that

   A. $a\neq0$

   B. $c=0$

   C. $b\neq0$

   D. $c\neq0$

10. If the roots of the quadratic equation $ax^2+bx+c=0$, $a,b,c \in R$ are additive inverses then

A. $\frac{-b}{a} = 0$

B. $\frac{c}{a} = 0$

C. $a = 0$

D. $\frac{c}{b} = 0$

Mathematics 30

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1. $y=ax^3+bx^2+cx+d$, $a,b,c,d \in R$ always represents a cubic function, if

   A. $x \neq 0$

   B. $y = 0$

   C. $a \neq 0$

   D. $d \neq 0$

2. The factor theorem states that

   A. If a polynomial in x is a when $x=0$, then $x-a$ is a factor of the polynomial.

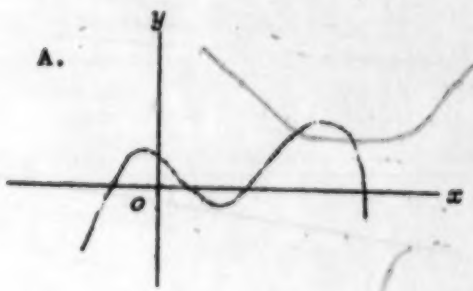
   B. If a polynomial in x is zero when $x=a$, then $x-a$ is a factor of the polynomial.

   C. If a polynomial in x is zero when $x=a$, then $x+a$ is a factor of the polynomial.

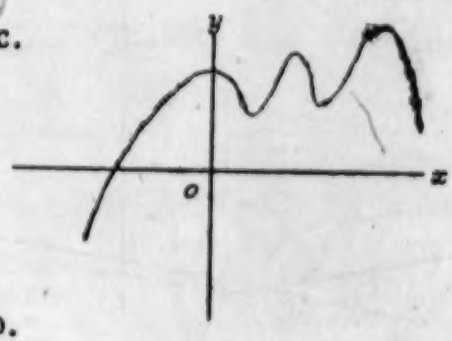
   D. If a polynomial in x is a when $x=0$, then $x+a$ is a factor of the polunomial.

3. Which one of the following represent a graph of $y=ax^5+bx^4+cx^3+dx^2+ex+f$ $a \neq o$, $a,b,c,d,e,f \in R$

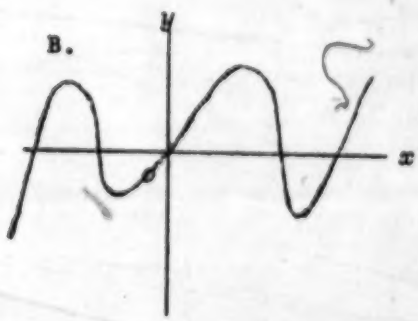
A.



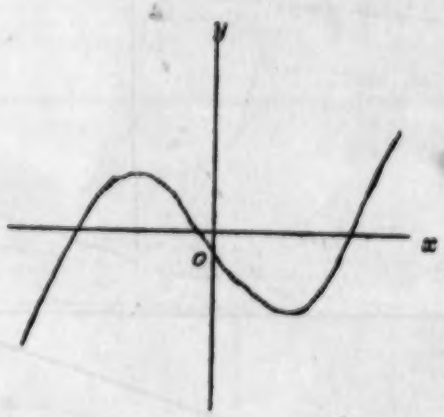
C.



B.



D.



4. The cubic equation with roots a,b and c is given by

   A. $(x-a)\ (x-b)\ (x-c) = 0$

   B. $(x+a)\ (x+b)\ (x+c) = 0$

   C. $(x-a)\ (x-b) = (x-c)$

   D. $x^3+ax^2+bx+c = 0$

5. Which of the following is a cubic equation

   A. $ax^3+bx^2+cx+d=y$, $a\neq 0$

   B. $ax^3+bx^2+cx+d=0$, $a=0$

   C. $ax^3+bx^2+cx+d=y$, $a=0$

   D. $ax^3+bx^2+cx+d=0$, $a\neq 0$

B2

Higher Level Quizzes Set I

Mathematics 30

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Be sure your name is on the answer sheet.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. $3^4 \times 3^5 \times 3^7 \times 3 =$

   A. 3^{16}

   B. 9^{16}

   C. 3^{17}

   D. 81^{17}

2. $\frac{12\ (xy)^6}{9x^{-2}\ y^4}$ expressed with denominator 1 is

   A. $4 \cdot 3^{-1} \cdot x^8 \cdot y^2$

   B. $12^{-1}\ x^8 y^2$

   C. $4 \cdot 3^{-1} \cdot x^4 y^2$

   D. none of these

3. $x^5 + x^7 =$

   A. x^{12}

   B. $2x^{12}$

   C. x^{35}

   D. none of these

4. $(7+8)+5 = 8+(7+5)$, This illustrates the

   A. Commutative property of addition

   B. Associative property of addition

   C. Closure property of addition

   D. Distributive property of addition

5. In which step, A, B, C or D does an error occur.
   Let $x=y$ $x \neq 0$ $y \neq 0$ (Remember $x=y$ in each step)
   Multiply by x $x^2 = xy$

   A. Subtract y^2 $x^2-y^2 = xy-y^2$

   B. Factor $(x+y)(x-y) = y(x-y)$

   C. Divide by $(x-y)$ $x+y = y$

   D. Substitute $x=y$ $2y = y$
   $2 = 1$

6. The property which is illustrated by $19 \times 17 + 19 \times 3 = 19\ (17 + 3)$ is known as

   A. Associative property of addition

   B. Commulative property of multiplication

   C. Closure property of addition

   D. Distributive property

7. $(2^{-1})\ (5^{-1}) =$

   A. 7^{-1}

   B. 10^{-1}

   C. 10^{-2}

   D. 7^{-2}

8. A number is expressed in exponential form with a base of 3. Find the exponent given that the number becomes 729 when the exponent is increased by 2.

   A. 4

   B. 3

   C. 2

   D. 5

9. Determining the square root of $15x^6$ would change.

   A. The coefficient, base, and exponent

   B. Only the base and exponent

   C. Only the coefficient and the base

   D. Only the exponent and coefficient

10. If $2^2 + 4^{\frac{1}{2}} + 16^x = 10$, then x =

    A. -1

    B. 0

    C. 1

    D. None of these

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. Written as an entire radical $(a-b)^2\sqrt{a+2b}$ becomes

   A. $\sqrt{(a-b)^2\,(a+2b)}$

   B. $\sqrt{(a-b)\,(a+2b)}$

   C. $(a-b)\sqrt{a+2b}$

   D. $\sqrt{(a-b)^4\,(a+2b)}$

2. Multiply $\sqrt{\frac{15}{7}} \times \sqrt{\frac{14}{3}} \times \sqrt{27}$, express the result with simplest radicand

   A. $6\sqrt{2}$

   B. $12\sqrt{2}$

   C. $24\sqrt{2}$

   D. $3\sqrt{32}$

3. $\sqrt{75} + 2\sqrt{48} - 7\sqrt{81}$ is equal to:

   A. $-60\sqrt{3}$

   B. $13\sqrt{3} - 63$

   C. $9\sqrt{3} - 63$

   D. $-63\sqrt{3}$

4. $(4\sqrt{3} + \sqrt{2})\,(3\sqrt{3} - \sqrt{2})$ is equal to:

   A. $34 - \sqrt{6}$

   B. $34 + \sqrt{6}$

   C. $12\sqrt{3} - \sqrt{2}$

   D. $12\sqrt{3} + \sqrt{2}$

5. If $\sqrt{3}\,x = \sqrt{2}$, then the value of x expressed with rational denominator is

   A. $\frac{\sqrt{2}}{\sqrt{3}}$

   B. $\frac{\sqrt{5}}{3}$

   C. $\sqrt{3}$

   D. $\frac{\sqrt{6}}{3}$

6. If A={c,d} is the set of elements of an algebraic system and the operation * is defined by the table.

*	c	d
c	c	d
d	d	c

then the inverse of each element under the operation * is

A. c

B. d

C. It is not possible to tell

D. Each element is its own inverse

7. Which one of the following sets is closed under the operation of addition?

A. {2,3,5,6,8,9,...}

B. {1,3,5,7,9,...}

C. {5,10,15,25,...}

D. {1,2,4,5,7,8,...}

8. The domain of the relation defined by $H=\{(s,t) \mid s^2-t^2-16=0,\ s,t\in R\}$ is

A. $\{s \mid s \geq 16,\ s\in R\}$

B. $\{s \mid s \geq 4,\ s\in R\}$

C. $\{s \mid |s| \geq 4,\ s\in R\}$

D. $\{s \mid |s| \leq 4,\ s\in R\}$

9. The graph of the relation $H=\{(x,y) \mid y=|x+5|,\ x,y\in R\}$ is symmetrical with respect to

A. x-axis

B. y-axis

C. Line whose equation is x=-5

D. Line whose equation is y=x

10. A baseball league involves 5 teams. If each team plays each other team twice, then the number of games that must be scheduled is:

A. 20

B. 10

C. 25

D. 15

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. If $f=\{(x,y) \mid y=4x+1,\ x\in R\}$ then the value of $f^{-1}[f(4)]$ is

   A. $2\frac{1}{2}$

   B. 4

   C. $\frac{3}{4}$

   D. none of these

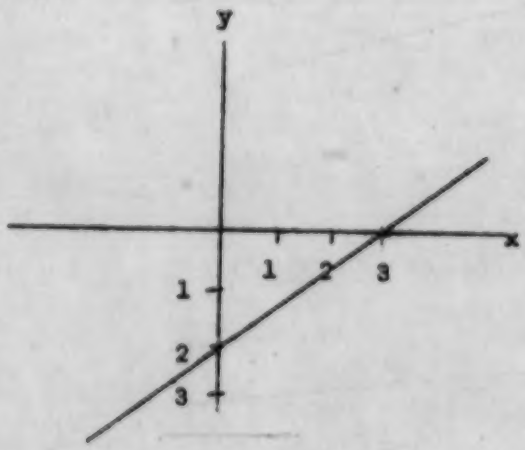
2. The graph is a graph of which of the following functions?

   A. $\{(x,y) \mid 3y+6=2x,\ x\in R\}$

   B. $\{(x,y) \mid 3y=2x+6,\ x\in R\}$

   C. $\{(x,y) \mid 2y=3x-6\ x\in R\}$

   D. $\{(x,y) \mid 3y-2x+2=0\ x\in R\}$



3. If $f(x)=x+3$, then $f[f(x)]$ is

   A. x

   B. $(x+3)^2$

   C. $x+6$

   D. none of these

4. The inverse of the function $y=x^2$ is a relation

   A. which is also a function

   B. with domain $\{x \mid x\in R\}$

   C. with domain $\{x \mid x\geq 0,\ x\in R\}$

   D. with range $\{y \mid y\in R\}$

5. The following data are given for a banquet:
   Tickets are sold at $5.00 per person
   Expenses:

Hall Rental	$25.00	
Food	2.00	per person
Refreshments	.50	per person
Miscellaneous	5.00	plus $ .50/person

   If profit is y dollars and x persons attend, the linear equation which expresses this relation is which of the following

   A. $y = 8x+30$

   B. $y = 8x-30$

   C. $y = 2x+30$

   D. $y = 2x-30$

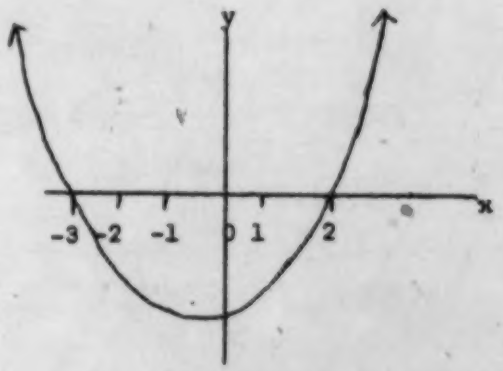
6. The values of x for which the function is negative are

   A. $-3>x>2$

   B. $-3<x<2$

   C. $-3\leq x\leq 2$

   D. $-3<x>2$



7. An algebraic sentence in x and y which defines the function $H=\{(-2,-1), (-1,0), (0,1), (1,2), (2,3)\}$ is

   A. $y=x+1, -2\leq x\leq 2, x,y\in R$

   B. $y=x+1, -2\geq x\geq 2, x,y\in I$

   C. $y=x+1, -2\geq x\geq 2, x,y\in R$

   D. $y=x+1, -2\leq x\leq 2, x,y\in I$

8. If $f:x \to \frac{3}{x+2}$, $x \neq -2$, $x \in R$, then f^{-1} is

   A. $f^{-1}:x \to \frac{3-2x}{x}$, $x \neq 0$, $x \in R$

   B. $f^{-1}:y \to \frac{3}{y+2}$, $y \neq -2$, $y \in R$

   C. $f^{-1}:x \to \frac{3-2x}{x}$, $x \neq -2$, $x \in R$

   D. $f^{-1}:x \to 3-2x$, $x \in R$

9. If $f:x \to 7^x$, $x \in R$, the defining equation of f^{-1} is

   A. $y=\log_7 x$, $x \in R$

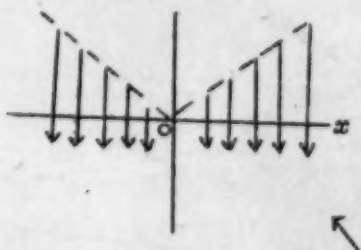
   B. $y=7^y$, $y \in {}^+R$

   C. $y=\log_x 7$, $x \in R$

   D. $y=\log_7 x$, $x \in {}^+R$

10. For $f=\{(x,y) \mid y<|x|, , x,y \in R\}$
    The graph of the relation is

A.



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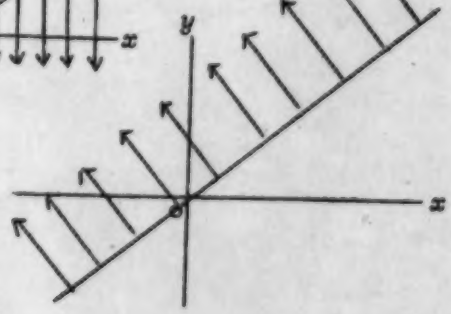

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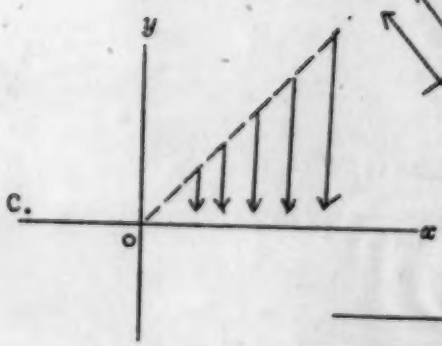

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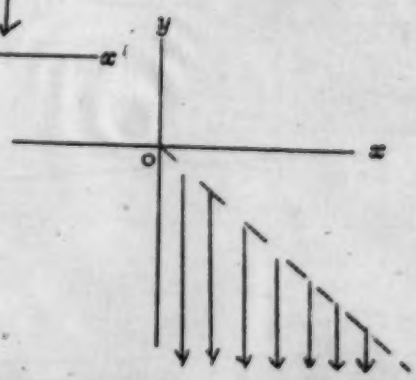

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. The maximum value of the function $7-2x-5x^2$ is

   A. 14.4

   B. 6.8

   C. -7.2

   D. 7.2

2. The equation of the axis of symmetry of the graph of $\{(x,y) \mid y=-2x^2-5x-7,\ x \in R\}$ is

   A. $x=\frac{-5}{4}$

   B. $x=\frac{5}{4}$

   C. $x=\frac{-5}{2}$

   D. $x=\frac{5}{2}$

3. For the function $q: x \to 2x^2-3x+1, x \in R$, the range is

   A. $\{y \mid y \geq -\frac{1}{4}, y \in R\}$

   B. $\{y \mid y \leq -\frac{1}{8}, y \in R\}$

   C. $\{y \mid y \geq -\frac{1}{8}, y \in R\}$

   D. $\{y \mid y \leq \frac{15}{8}, y \in R\}$

4. In order that the graph of the function $3x^2+kx+36$ may be tangent to the x-axis, the value of k must be

   A. ± 6

   B. 0

   C. 5

   D. none of these

5. The graph of the function $H=\{(x,y) \mid y=7x^2-2x+5, x \in R\}$

   A. cuts the x-axis at two points

   B. is entirely above the x-axis

   C. is entirely below the x-axis

   D. is tangent to the x-axis

6. The vertex of the graph of $y=5x^2-4x+1$ is

   A. $(\frac{2}{5}, \frac{1}{5})$

   B. $(\frac{4}{5}, \frac{1}{5})$

   C. $(\frac{2}{5}, \frac{2}{5})$

   D. $(\frac{-4}{5}, \frac{2}{5})$

7. The domain for which the function $12+5x-2x^2$ is positive is

   A. $\{-\frac{1}{4}<x<-\frac{3}{2}, x \in R\}$

   B. $\{\frac{3}{2}\leq x\leq -4, x \in R\}$

   C. $\{4<x<-\frac{3}{2}, x \in R\}$

   D. $\{-\frac{3}{2}<x<4, x \in R\}$

8. ~~$y=$~~ $-(x-5)^2+7$ has

   A. maximum value -5

   B. minimum value 7

   C. maximum value $\neq$ 7

   D. maximum value 5

9. If the function x^2-8x+p has a minimum value of 12, then the value of p is

   A. 4

   B. 19

   C. 28

   D. 10

10. The graph of $y=x^2+5$ is symmetrical with respect to

    A. the x-axis only

    B. the y-axis only

    C. the origin

    D. the x-axis and the y-axis

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. If A(-3,8) and B(2,3) are the end points of the diagnol of a square, then the area of the square in square units is

   A. $25\sqrt{2}$
   B. 25
   C. 10
   D. $\frac{5\sqrt{2}}{2}$

2. The equation of a st. line on P (5, -3) and with slope 7 is

   A. $y-3 = 7(x-5)$
   B. $7x-y-38 = 0$
   C. $7x+y-32 = 0$
   D. $y-5 = 7(x+3)$

3. If A (0,3) and B(4,-3) are the end points of the diameter of a circle then the radius of the circle is

   A. $2\sqrt{13}$
   B. $\sqrt{26}$
   C. $\sqrt{13}$
   D. $4\sqrt{13}$

4. The slope of the line defined by $3x - 2y = 4$ is

   A. $\frac{3}{2}$
   B. $\frac{2}{3}$
   C. $\frac{3}{4}$
   D. $\frac{4}{3}$

5. The geometric condition implied by the form of the equation $y = 6x-9$ is

   A. slope 6, y-intercept 9
   B. slope 6, y-intercept -9
   C. slope 9, y-intercept 6
   D. slope 6, x-intercept -9

6. The equation of a line with x-intercept 5 and y-intercept 2 is

   A. $y = \frac{-2}{5}x + 2$
   B. $y = 2x + 5$
   C. $2x + 5y - 10 = 0$
   D. $2x - 5y - 10 = 0$

7. If a teacher says that the equation $Ax + By + C = 0$ can be expressed in the form $y = mx + b$, then the assumption implicit in the statement of the teacher is

   A. It can be easily done
   B. This is the way to find the slope and y-intercept of the line $An + By + C = 0$
   C. $B \neq 0$
   D. $A \neq 0$

8. The slope of the line on $P(7,-5)$ and $S(-3,8)$ is

   A. $-\frac{10}{13}$
   B. $\frac{10}{13}$
   C. $\frac{13}{10}$
   D. $\frac{-13}{10}$

9. To find the general expression for the distance between any two points, a teacher takes two points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$. A student knows that

   A. P_2 is farther away from the origin than P_1
   B. Both P_1 and P_2 have positive coordinates
   C. P_1 and P_2 are two distinct points
   D. knowing P_1 we can find P_2

10. The slope of lines perpendicular to the line $2x + 5y - 7 = 0$ is

    A. $\frac{5}{2}$
    B. $\frac{-2}{5}$
    C. $\frac{-5}{2}$
    D. None of these

Mathematics 30

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1. The solution set of $2x^2-8=0$ is

   A. {2}

   B. {2,2}

   C. {2,-2}

   D. $\emptyset$

2. The roots of the equation $2^{2x}-6(2^x)+8=0$ are

   A. 1,2

   B. 2,4

   C. -1,-2

   D. -1,2

3. John and his father drove to a town 294 miles away. John drove the family car at an average speed of 7 miles per hour faster than his father drove the farm truck. It took John an hour less than it did his father. What was Johns average speed in miles per hour?

   A. 48

   B. 57

   C. 42

   D. 49

4. If one root is 3, then missing term in x^2-5x+_____$=0$ is

   A. 3

   B. 5

   C. 6

   D. -6

5. If m and n are the roots of the equation $3x^2-6x+1=0$ then $\frac{1}{m^2}+\frac{1}{n^2}$ is equal to

   A. 36

   B. 30

   C. 8

   D. 2

6. The real value(s) of k for which the quadratic equation $(2k-1)x^2-(4k^2+2k-2)\,x + 8k-2=0$ has roots which are additive inverses are

   A. $-1,\frac{1}{2}$

   B. -1

   C. $\frac{1}{2}$

   D. $\frac{1}{4}$

7. The hypotenuse of a right triangle is 25 inches long. The difference between the lengths of the other two sides is 5 inches. The length of the longer side is

   A. 10 inches

   B. 12 inches

   C. 15 inches

   D. 20 inches

8. If one root of the equation $kx^2+\ell x+m=0$ is double the other, the coefficient k, ℓ, and m are related as follows

   A. $2\ell^2 = 9km$

   B. $4\ell^2 = 9m$

   C. $\ell^2 - 4km = 0$

   D. $9\ell^2 = 2km$

9. Given that $3x^2-4x+k=0$ has real roots, then

   A. $k \geq \frac{4}{3}$

   B. $K < \frac{4}{3}$

   C. $k \leq \frac{4}{3}$

   D. $k > \frac{4}{3}$

10. An equation of the type $ax^2+bx+c=0$ whose roots are 3 and $-\frac{1}{2}$ is

A. $x^2-2x-3 = 0$

B. $x^2+2x-3 = 0$

C. $2x^2-5x-3 = 0$

D. $2x^2+5x-3 = 0$

Mathematics 30

This is 10 minutes-test. It contains 5 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. One of the roots of $x^3-6x^2-9x+14=0$ is

   A. -1

   B. 2

   C. 3

   D. none of these

2. The roots of $(x^2-3x+2)\ (x)\ (x-3) = 0$ are

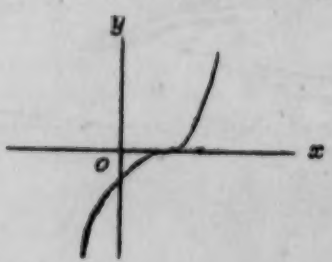
   A. 0,3

   B. 0, -1, -2, -3

   C. 0, 1, 2, 3

   D. 1, 2, 3

3. A complete description of the roots of the corresponding equation of the cubic function whose graph appears below is



   A. one real root

   B. one real root, two non-real roots

   C. three real and equal roots

   D. three real and distinct roots

4. If $y=x-x^3, x \in R$, the domain for which y is negative is (Hint: a sketch may be helpful)

   A. $\{x \mid x<-1 \text{ or } o<x<1\}$

   B. $\{x \mid -1<x<o \text{ or } x>1\}$

   C. $\{x \mid o<x<-1 \text{ or } x>-1\}$

   D. $\{x \mid -1 \leq x \leq o \text{ or } x \geq 1\}$

5. A factor of y^3-2y^2-9 is

A. $y-1$

B. $y+3$

C. $y-3$

D. $y+2$

B3

Final Examination I

Mathematics 30

This is 66 minutes test. It contains 33 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. "If a,b ∈R, then one and only one of the following is true:
   a>b or a=b or a<b"
   This property is known as

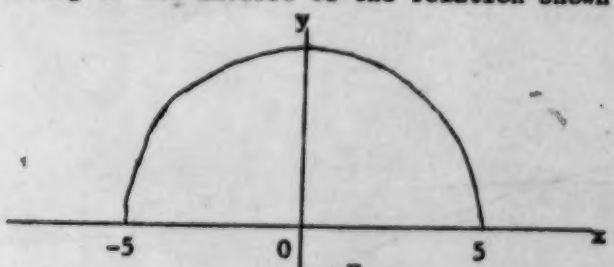
   A. Transitive property
   B. Completeness property
   C. Trichotomy property
   D. Associative property

2. A function f is said to be a many-to-one function if

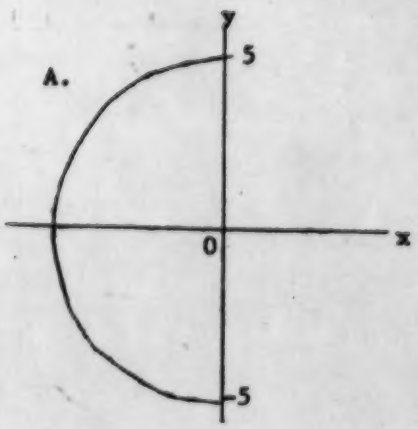
   A. there is at least one element of the range of f which is the image under f of two or more elements of the domain of f
   B. there is one and only one element of the range of f which is the image under f of two or more elements of the domain of f
   C. there is at least one element of the domain of f which is mapped to two or more elements of the rnage of f
   D. every element of the domain of f is mapped to two or more elements of the range of f

3. Which of the following is the inverse of the relation shown

Given relation



A.



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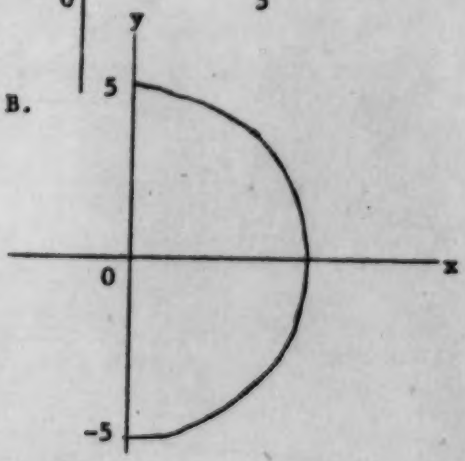

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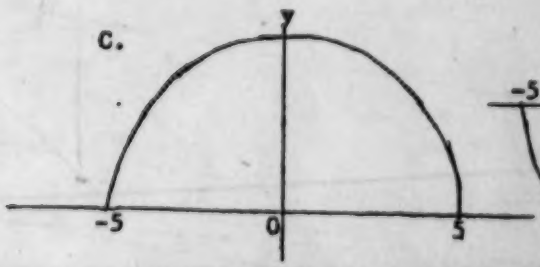

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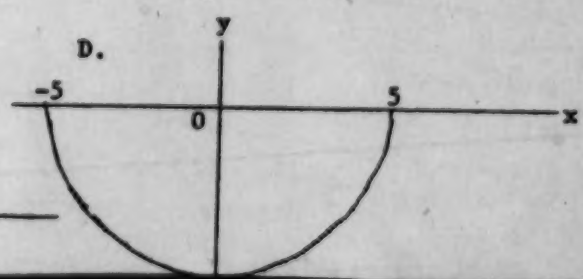


4. A cubic equation always has

   A. more than three roots
   B. less than three roots
   C. three roots
   D. two non-real and one real root

5. If $2^{x+y} = 32$, and $27^{x/3} = 9$ then y is

   A. -2
   B. -1
   C. 0
   D. 3

6. A set of numbers is closed under addition if

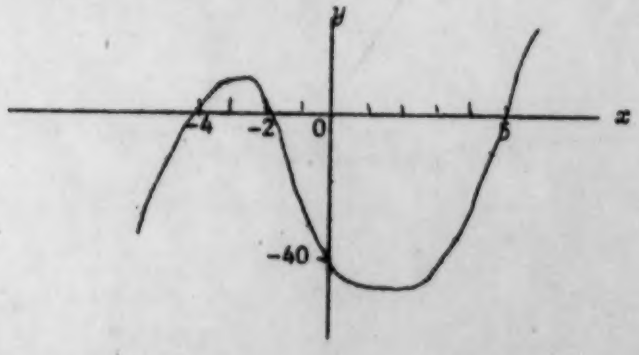
   A. there is at least one number of the set which when added to another number of the set gives a number equal to some other number of the set
   B. the result of addition does not depend upon the order of the numbers in the set
   C. the result of addition of any two numbers of the set is always a number of the set
   D. the addition cannot be carried out among the numbers of the set

7. In a quartic equation with real coefficient it is given that one root is real and one non-real. Without solving the equation one knows that the remaining two roots are

   A. real and unequal
   B. real and equal
   C. non-real
   D. none of these

8. The graph most closely corresponding to $f(x) = (2+x)(x^2-x-20)$

A.



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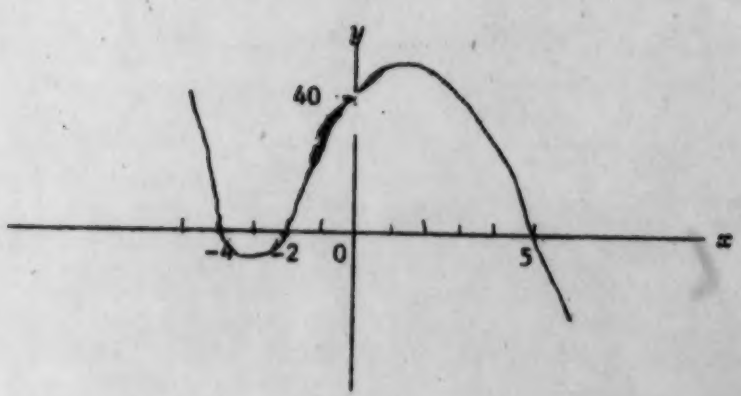

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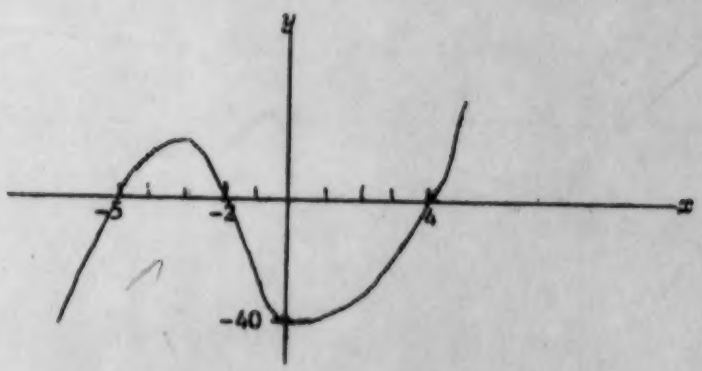
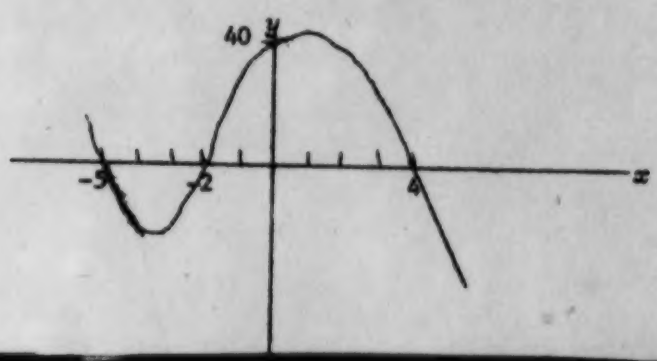


D.



9. If the set of all the ordered pairs of a function are given then the range of its inverse function, if it exists, is given by

   A. the set of first members of each ordered pair
   B. the set of second members of each ordered pair
   C. the set of first members of the first and the last ordered pairs
   D. the set of the second members of the first and the last ordered pairs

10. When the equation $x^2+6x=8$ is solved by completing square, the number that is added to both sides is

   A. 9
   B. 2
   C. -9
   D. 3

11. If $\sqrt{5} = 2.236$, find correct to 2 decimal places the value of $\frac{20}{\sqrt{125}}$

   A. 44.72
   B. 8.96
   C. 1.79
   D. none of these

12. The equation of a line on A(5,2) and the midpoint of the line segment joining B(-2,4) and C(6,-10) is

   A. $3x-5y-19=0$
   B. $3x-5y+19=0$
   C. $5x-3y-19=0$
   D. $3x+3y-19=0$

13. Given $\frac{y-3}{x+2} = \frac{-2}{5}$, one knows that this represents

   A. the equation of a straight line with slope $\frac{-2}{5}$ and on a point (-2,3)
   B. the slope of two given points
   C. the equation of a straight line with slope $\frac{-2}{5}$ and on a point (2,-3)
   D. the condition for $y=1$ and $x=3$

14. The value of k for which $(2k+3)x^2-2k^2x+kx+4k-5=0$ has reciprocal roots is

   A. 0
   B. $\frac{5}{4}$
   C. -4
   D. none of these

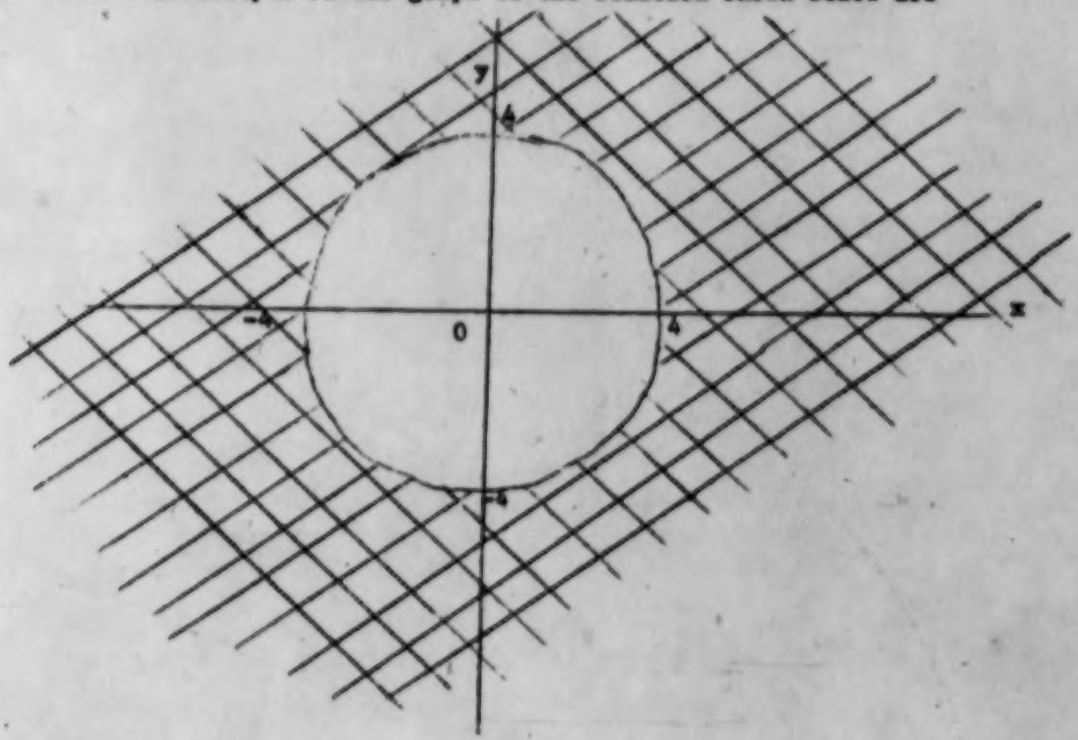
15. If the graph of a guadratic function is given then the roots of the corresponding quadratic equation are given by

A. the y-intercept/s of the graph
B. the x-intercept/s of the graph
C. the vertex of the graph
D. the x-intercept/s and the y-intercept/s of the graph

16. $3x+4y-3=0$ is a tangent to a circle with centre C(2,3), the radius of the circle is

A. 3
B. 7
C. 5
D. 4

17. The x-intercepts of the graph of the relation shown below are



A. $\{x \mid -4 \leq x \leq 4, x \in R\}$

B. $\{x \mid |x| \leq 4, x \in R\}$

C. $\{x \mid x = \pm 4, x \in R\}$

D. $\{x \mid |x| \geq 4, x \in R\}$

18. If a dime and a die are thrown together then the number of possible outcomes is

A. 2
B. 6
C. 8
D. 12

19. If one root of the quadratic equation $ax^2+bx+c=0$ $a,b,c \in R$ is equal to zero then

A. it is not a quadratic equation
B. $c=0$
C. $b=0$
D. $a=0$

20. The y-axis is the axis of symmetry of $y=4x^2-3kx-15x$. The value of k is

A. 7/3
B. -5
C. 15/4
D. none of these

21. The slope of $Ax+By+C=0$ is found by

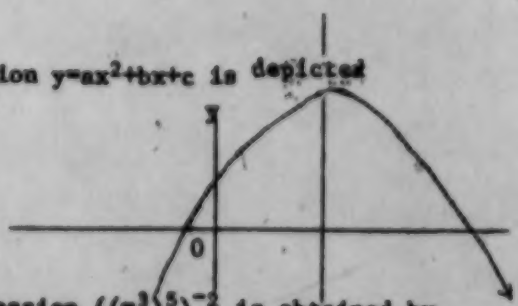
A. using the slope formula $m=\frac{y_2-y_1}{x_2-x_1}$

B. writing the line $Ax+By+C=0$ in the form $y=mx+b$ and finding the coefficient of x

C. writing the line $Ax+By+C=0$ in the form $y=mx+b$ and finding the coefficient of y

D. none of these

22. If the graph of the quadratic function $y=ax^2+bx+c$ is depicted as in the sketch, then we know that



A. $a<0$; $b<0$
B. $a>0$; $c<0$
C. $b>0$; $a<0$
D. $b^2-4ac=0$, $a<0$

23. The index of the base x in the expression $((x^3)^5)^{-2}$ is obtained by

A. adding the intergers 3,5 and -2
B. multiplying the intergers 3,5 and -2
C. adding 3 and 5 and multiplying the sum by -2
D. adding 3 and 5 and dividing the sum by -2

24. Which of the following set of ordered pairs describes the inverse function for $f=\{(x,y) \mid y=x+3, -1 \leq x \leq 3, x \in R\}$

A. $\{(-1,2), (0,3), (1,4), (2,5), (3,6)\}$
B. $\{(1,-2), (0,-3), (-1,-4), (-2,-5), (-3,-6)\}$
C. $\{(2,-1), (3,0), (4,1), (5,2) (6,3)\}$
D. $\{(-1,-2), (0,-3), (1,-4), (2,-5), (3,-6)\}$

25. The slope of a st. line which is perpendicular to a st. line with slope m is

A. $-1/m$
B. m
C. $-m$
D. $1/m$

26. If one root of the equation $ax^2+bx+c=0$ is reciprocal of the other then

A. $a=b$
B. $-b/a = 0$
C. $a/b = 1$
D. $c/a = 1$

27. Simplify $(a^{x-y})^{y+x} \times (a^{x^2+y^2})$

A. a^{2x^2}

B. a^{2y^2}

C. $a^{(x+y)^2}$

D. $a^{2x+x^2+y^2}$

28. $3^4 \times 9^2 =$

A. 27^6
B. 27^8
C. 3^{16}
D. 3^8

29. If $L=\{(x,y) \mid Ax+By+C=0, x,y \in R\}$, it follows that

A. L is a function for all real values of A, B and C
B. when A=0, the domain is R but the range is the one element set $\{-C/B\}$
C. when A=0, the slope is undefined
D. the graph of L will always intersect both the x and y axes

30. The coordinates of the vertex of $y=ax^2+bx+c$, $a \neq 0$ are

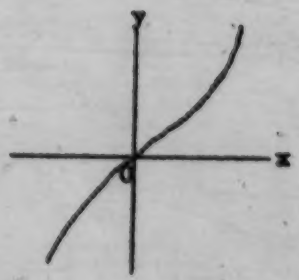
A. $\left(\frac{-b}{2a}, \frac{b^2-4ac}{4a}\right)$

B. $\left(\frac{-b}{2a}, \frac{4ac-b^2}{4a}\right)$

C. $\left(\frac{-b}{2a}, \frac{4ac-b^2}{2a}\right)$

D. $\left(\frac{-b}{a}, \frac{b^2-4ac}{2a}\right)$

31. The graph shown is symmetrical with respect to



A. the x-axis
B. the y-axis
C. the origin
D. the x-axis, the y-axis and the origin

32. The graph of the quadratic function defined by $y=ax^2+bx+c$ always has x-intercepts if

A. $a < 0$ and $b > 0$
B. $a > 0$ and $c < 0$
C. $a > 0$ and $c > 0$
D. $a < 0$ and $b < 0$

33. How many elements has the solution set of the equation
$(x+5)(x-2) = (x+7)(x-4)$

A. one
B. two
C. none
D. infinite

CI

Lower Level Quizzes Set II

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. R is a set of real numbers. N is a set of natural numbers I is a set of integers. C is a set of complex numbers. Which of the following statements is true

   A. R is subset of C
   B. C is subset of I
   C. C is subset of R
   D. C is subset of N

2. If any two complex numbers are given, then one can always find out

   A. the greater complex number
   B. the negative complex number
   C. the smaller complex number
   D. none of the above

3. If $z_1, z_2 \in C$, then the distance between the points z_1 and z_2 in the complex plane is given by

   A. $\sqrt{z_1^2 + z_2^2}$

   B. $\sqrt{z_1 + z_2}$

   C. $|z_1 - z_2|$

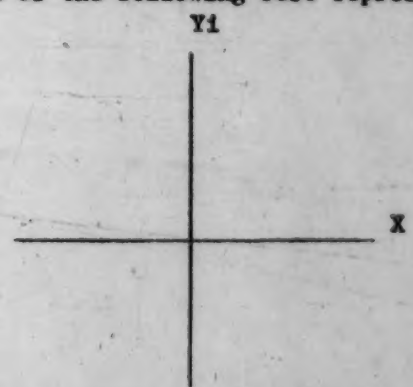
   D. $|z_1 + z_2|$

4. A complex number $a+bi$ is equal to a complex number $c+di$ if and only if

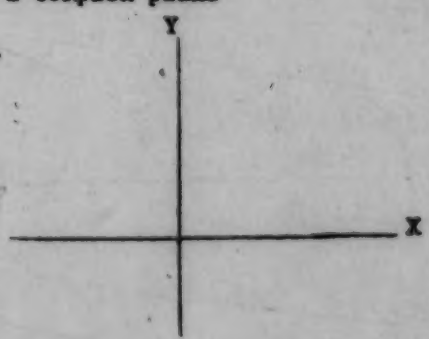
   A. $a=c$
   B. $b=d$
   C. $a=c$ and $b=d$
   D. $a=b$ and $c=d$

5. Which of the following best represents a complex plane

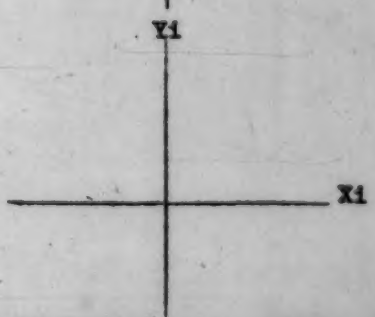
   A.



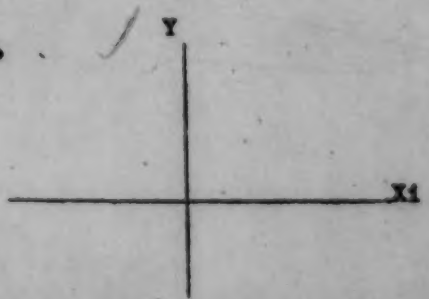
   C.



   B.



   D.



6. The distance in the complex plane, between the point representing the complex number and the origin is called

   A. obscissa of the complex number
   B. ordinate of the complex number
   C. conjugate of the complex number
   D. none of the above

7. The *Principle of Equivalent Fractions* provides an easier method of

   A. adding two complex numbers
   B. subtracting two complex numbers
   C. computing the quotient of two complex numbers
   D. finding the distance between two complex numbers

8. The standard form of a complex number is

   A. $a-bi$
   B. $a+bi$
   C. $ai+bi$
   D. $ai+b$

9. In the complex number $a+bi$, i is equal to

   A. $\sqrt{1}$
   B. $\sqrt{-1}$
   C. -1
   D. 1

10. The method of computing the quotient of two complex numbers is

    A. to multiply the numerator and the denominator of the quotient by the conjugate complex of the denominator
    B. to multiply the numerator and the denominator of the quotient by the conjugate complex of the numerator
    C. to multiply the numerator of the quotient by the conjugate complex of the numerator and the denominator of the quotient by the conjugate complex of the denominator
    D. to multiply the numerator of the quotient by the conjugate complex of the denominator and the denominator of the quotient by the conjugate complex of the numerator

Mathematics 30

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. The centre of the circle defined by the equation $x^2 + y^2 + 2gx + 2fy + c = 0$ is

   A. $(-f,-g)$
   B. $(g,-f)$
   C. $(-g,-f)$
   D. $(-g,f)$

2. The equation of a circle with centre $C(h,k)$ and radius r is

   A. $(h-x)^2 + (k-y)^2 = r^2$
   B. $(x-h)^2 + (y-k)^2 = r^2$
   C. $\sqrt{(x-h)^2 + (y-k)^2} = r^2$
   D. $(x+h)^2 + (y+k)^2 = r^2$

3. If a parabola is defined by an equation of the form $y^2 = 4px$, then the vertex of the parabola is

   A. (p,o)
   B. (o,p)
   C. $(-p,o)$
   D. none of the above

4. If $x^2 + y^2 + 2gx + 2fy + c = 0$ defines a circle then which of the following is always true

   A. $g=0 \quad f=0$
   B. $g+f-c>0$
   C. $g^2+f^2-c>0$
   D. $g^2+f^2-c<0$

5. The parabola defined by an equation of the form $y^2 = bx + a$, $c \neq 0$, is symmetrical with respect to

   A. x-axis
   B. y-axis
   C. the origin
   D. none of the above

6. The radius of the circle defined by the equation $x^2 + y^2 + 2gx + 2fy + c = 0$ is

   A. $\sqrt{g^2 + f^2 + c}$
   B. $g^2 + f^2 - c$
   C. $\sqrt{g^2 + f^2 - c}$
   D. $g^2 + f^2 + c$

7. The focus of the parabola defined by the equation $y^2 = 4px$ is 149

A. (o,p)
B. (p,o)
C. $(-p,o)$
D. $(o,-p)$

8. A parabola is the set of points each of which is equidistant from a fixed point and a fixed straight line. The fixed point is called

A. directrix
B. vertex
C. the origin
D. focus

9. If the equation of a relation is $y^2 = 4px$ and $p<o$ then the graph of the relation opens

A. upward
B. downward
C. to the left
D. to the right

10. The standard form of the equation of the circle is

A. $(x-h)^2 - (y-k)^2 = r^2$
B. $(x+h)^2 + (y+k)^2 = r^2$
C. $x^2 + y^2 + 2gx + 2fy + c = 0$
D. $(x-h)^2 + (y-k)^2 = r^2$

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1. The length of the minor axis of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \quad a>b$ is

   A. b
   B. $2b$
   C. a
   D. $2a$

2. An ellipse is the set of points such that the sum of the distances form each of its points to two fixed points is constant. In $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, the constant sum is

   A. a
   B. b
   C. c
   D. none of the above

3. The length of the semi-major axis of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, $a>b$ is

   A. a
   B. b
   C. $2a$
   D. $2b$

4. If $(c,0)$ is a focus of the hyperbola defined by the equation $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, then which of the following relationships is true?

   A. $a^2-b^2 = c^2$
   B. $a^2+b^2 = c^2$
   C. $a^2+c^2 = b^2$
   D. $a^2-c^2 = b^2$

5. The defining equation of a relation is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, the length of the transverse axis is

   A. a
   B. b
   C. $2a$
   D. $2b$

6. The equation of an asymptote of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is

   A. $y=\frac{-b}{a}x$
   B. $y=\frac{a}{b}x$
   C. $x=\frac{b}{a}y$
   D. none of the above

7. The definition of a hyperbola is the set of points such that the absolute value of

   A. the difference of the distances from each point to two fixed points is a constant which is less than the distance between the two points
   B. the sum of the distances from each point to two fixed points is a constant which is less than the distance between the two points
   C. the difference of the distances from each point to two fixed points is a constant which is greater than the distance between the two points
   D. the difference of the distance from each point to two fixed points is a constant which is equal to the distance between the two points

8. The standard form of equations of conjugate hyperbolas differ only in the sign(s) of the

   A. x^2 term
   B. constant term
   C. y^2 term
   D. both the x^2 and y^2 terms

9. The vertices of a hyperbola will always be on

   A. the x-axis
   B. the y-axis
   C. the conjugate axis
   D. the transverse axis

10. The foci of an ellipse <u>always</u> lie on

   A. the major axis
   B. the x-axis
   C. the y-axis
   D. the minor axis

C2

Higher Level Quizzes Set II

Mathematics 30

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Do not start until told to do so. Stop when asked.

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There is only one correct answer for every question. A question with more than one recorded answers will not be marked. If you change your mind about an answer be sure the first mark is completely erased.

DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. The distance in a complex plane between $3-4i$ and $4-3i$ is

   A. $\sqrt{2}$
   B. $9\sqrt{2}$
   C. $\sqrt{82}$
   D. 9

2. The modulus of the complex number $\sqrt{3} - \sqrt{13}\, i$ is

   A. 16
   B. $4i$
   C. 4
   D. $-4i$

3. If $x = 1 + \sqrt{-3}$, then the value of $x^2 - 2x + 5$ is

   A. 1
   B. 7
   C. $1 + 4\sqrt{3}\, i$
   D. $7 + 4\sqrt{3}\, i$

4. If $(3 + 7i) + (2x - yi) = 7 - 11i$ then

   A. $x = 5$, $y = 18$
   B. $x = 2$, $y = 18$
   C. $x = 2$, $y = -18$
   D. $x = 4$, $y = -18$

5. If $x - yi = 5 + i$, then

   A. $x = 5$, $y = 0$
   B. $x = 5$, $y = -i$
   C. $x = 5$, $y = 1$
   D. $x = 5$, $y = -1$

6. The value of z which satisfies the equation $\frac{5 + 3i}{z} = 3 - 2i$ is

   A. $9/13 + 19/13\, i$
   B. $9/4 - 19/4\, i$
   C. $9/5 + 19/5\, i$
   D. $21/4 - i$

7. $3i^4 + \sqrt{-25}\, i^8 + 5\sqrt{-4}\, i^{26}$ is the equivalent of

   A. $3 - i$
   B. $3 - 5i$
   C. $-3 + 15i$
   D. $3 + 11i$

8. The graph of $A = \{z \mid |z - 5 + 4i| = 4, z \in C\}$ in the complex plane is

A. a circle with centre $5 + 4i$ and radius 4
B. a circle with centre $5 - 4i$ and radius 2
C. a circle with centre $-5 + 4i$ and radius 4
D. a circle that touches the x-axis

9. The values of x and y which will satisfy the equation $(2x + 3yi) - (y - 2xi) = -3 - 7i$ are

A. $x = 2$, $y = 1$
B. $x = -2$, $y = -1$
C. $x = -1$, $y = -2$
D. $x = -2$, $y = 1$

10. The multiplicative inverse of $2 + 3i$ in the standard form is

A. $-2 - 3i$
B. $2/13 - 3/13\ i$
C. $3/13 - 2/13\ i$
D. $2/13 + 3/13\ i$

Mathematics 30

This is 20 minutes test. It contains 10 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

Be sure your name is on the answer sheet.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. A parabolic arch has a width at the ground of 80 feet and a height at the center of 40 feet. Its height 15 feet in from either end is

   A. 25 ft.
   B. $15\frac{5}{8}$ ft.
   C. $24\frac{3}{8}$ ft.
   D. 15 ft.

2. The vertex of the parabola defined by $y^2 = -(20x + 60)$ is

   A. (-3, 0)
   B. (3,0)
   C. (60,0)
   D. (-60,0)

3. A parabola has its vertex at (5,0) and its directrix the line $x = 1$. F is the focus and P(x,y) is any point on the graph. The number of units in the line segment PF is:

   A. $1 - x$
   B. $x + 1$
   C. $\sqrt{(x-5)^2 + \frac{1}{4}y^2}$
   D. $\sqrt{(x-9)^2 + y^2}$

4. The directrix of the parabola defined by $y^2 = 24x$ is:

   A. (6,0)
   B. (-6,0)
   C. $x = 6$
   D. $x = -6$

5. The centre and radius of the circle defined by $x^2 + y^2 + 2x - 2y - 7 = 0$ are

   A. (-1,1) and $r = 3$
   B. (1,-1) and $r = 3$
   C. (1,1) and $r = 9$
   D. (-1,1) and $r = 9$

6. The equation of the st. line which is tangent to the circle defined by the equaiton $x^2 + y^2 = 25$ at the point A(4,-3) is

   A. $4x - 3y = 0$
   B. $4x - 3y - 25 = 0$
   C. $3x + 4y + 24 = 0$
   D. $4y - 3x - 25 = 0$

7. The centre of the circle $2x^2 + 2y^2 + 20x - 36y + 15 = 0$ is

   A. (5,9)
   B. (-10,18)
   C. (10,-18)
   D. (-5,9)

8. The restrictions placed on g, f and c if the equation $x^2 + y^2 + 2gx + 2fy + c = 0$ defines a circle with centre a point of the x axis

   A. $f=0$, $g^2 > c$
   B. $f=0$, $g^2 < c$
   C. $g=0$, $f^2 > c$
   D. $g=0$, $f^2 < c$

9. If a parabola may be defined by an equation of the form $y^2=4px$, then the equation of the parabola with focus a point of the line $3x-2y+27=0$ is

   A. $y^2=-9x$
   B. $y^2=36x$
   C. $y^2=-36x$
   D. none of the above

10. When the centre and the radius of a circle are given, one arrives at the standard form of the equation of the circle by using the fact that

   A. the radius is one-half the diameter
   B. the radius of a given circle always remains constant
   C. the centre of a circle is always a fixed point
   D. the distance between the centre and any point on the circle is always equal to the radius of the circle

Mathematics 30

This is 20 minutes test. It contains 10 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

Be sure your name is on the answer sheet.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. The length of the transverse axis of the hyperbola $16x^2 - 9y^2 - 144 = 0$ is

   A. 9
   B. 3
   C. 6
   D. 4

2. The length of the semi-minor axis of the ellipse defined by the equation $\frac{x^2}{25} + \frac{y^2}{16} = 1$ is

   A. 8
   B. 5
   C. 4
   D. 10

3. If the points of intersection of the graphs of $xy = 12$ and $x^2 + y^2 = 25$ are joined in succession the resulting figure is

   A. a trapezoid
   B. a triangle
   C. a rectangle
   D. a square

4. Four hyperbolas are:

   M: $\frac{x^2}{9} - \frac{y^2}{4} = 1$

   N: $\frac{x^2}{4} - \frac{y^2}{9} = 1$

   W: $\frac{x^2}{9} - \frac{y^2}{4} = -1$

   X: $\frac{x^2}{4} - \frac{y^2}{9} = -1$

   $9x^2 - 4y^2 = 0$ represents two straight lines which are the asymptotes of

   A. M & N
   B. N & W
   C. M & W
   D. N & X

5. The equation of an ellipse with centre (0, 0), one focus, (-8, 0), and semi-major axis of length 10 units is

   A. $36x^2 + 100y^2 = 3600$
   B. $100x^2 + 36y^2 = 3600$
   C. $64x^2 + 100y^2 = 6400$
   D. $100x^2 + 64y^2 = 6400$

6. An ellipse with centre at the origin has one focus at (0,-3) and an x-intercept of 4. Its major axis is

   A. 10
   B. 5
   C. 4
   D. 6

7. One focus of the hyperbola $\frac{x^2}{36} - \frac{y^2}{64} = 1$ is

   A. (0,8)
   B. (8,0)
   C. (10,0)
   D. (0-10)

8. The graph of $9(x + 1)^2 + 4(y - 3)^2 = 36$ is

   A. a circle
   B. a hyperbola
   C. two straight lines
   D. an ellipse

9. The graph of $x^2-4y^2=16$ can be described as a hyperbola with

   A. conjugate axis 8 units long
   B. transverse axis 2 units long
   C. one focus $(0,2\sqrt{5})$
   D. one focus $(2\sqrt{5}, 0)$

10. The eccentricity of an ellipse with centre at the origin is defined as

$$\text{eccentricity} = \frac{\text{distance from centre to focus}}{\text{distance from centre to intercept on major axis}}$$

The eccentricity therefore measures: (choose the best answer)

   A. the ratio of the distance from the centre to the focus <u>to</u> the distance from centre to the intercept on the major axis
   B. area of the ellipse
   C. the flatness of the ellipse
   D. all of the above

C3

Final Examination II

Mathematics 30

This is 30 minutes-test. It contains 15 multiple choice questions. All the questions are of equal value. Your score is the number of correct answers you mark.

Be sure your name is on the answer sheet.

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DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.

1. The equation of the directrix of the parabola $y^2 = 4px$ is

   A. $x = -p$
   B. $x - p = 0$
   C. $-p$
   D. $(p,0)$

2. $-2 + 6i$ and $-4i + 3$ are the end points of a diameter of a circle, then the centre of the circle is

   A. $1 + 2i$
   B. $5 - 10i$
   C. $1/2 + i$
   D. $-3 + 9/2\ i$

3. The eccentricity of an ellipse with centre at the origin is defined as

   $$\text{eccentricity} = \frac{\text{distance from centre to focus}}{\text{distance from centre to intercept on major axis}}$$

   If the distance from the centre to the intercept on the major axis is kept fixed and the distance from the centre to the focus becomes very small the eccentricity is close to zero. The graph of the relation

   A. approaches a circle
   B. reduces to a point
   C. becomes a straight line
   D. becomes a hyperbola

4. The length of the transverse axis of the hyperbola defined by the equation

   $$\frac{x^2}{36} - \frac{y^2}{64} = 1 \quad \text{is}$$

   A. 6
   B. 64
   C. 8
   D. 12

5. The point in the complex plane corresponding to the complex number $7 - i$ is

   A. (7, -1)
   B. (7, 0)
   C. (-1, 7)
   D. (0,7)

6. The method of computing the quotient of two complex numbers is

A. to multiply the numerator and the denominator of the quotient by the confugate complex of the denominator
B. to multiply the numerator and the denominator of the quotient by the confugate complex of the numerator
C. to multiply the numerator of the quotient by the confugate complex of the numerator and the denominator of the quotient by the confugate complex of the denominator
D. to multiply the numerator of the quotient by the confugate complex of the denominator and the denominator of the quotient by the confugate complex of the numerator.

7. The equation of the locus of points which divides the ordinates of the circle defined by $x^2 + y^2 = 25$ in the ratio of 4:1 is

A. $16x^2 - 25y^2 = 400$
B. $25x^2 + 16y^2 = 400$
C. $x^2 + y^2 = 16$
D. $16x^2 + 25y^2 = 400$

8. If a parabola may be defined by an equation of the form $y^2 = 4px$ then the equation of a parabola with focus a point P (-5,0) is

A. $y^2 = 20x$
B. $y^2 = -20x$
C. $y^2 = -5x$
D. $y^2 = 5x$

9. The equation of the parabola with vertex V(2,5) and focus F(7,5) is

A. $(y-5)^2 = 5\ (x-2)$
B. $(y-5)^2 = 20\ (x-2)$
C. $(y+5)^2 = 20\ (x+2)$
D. $y^2 = 20x$

10. If (c,o) and (-c,o) are the foci of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ then the statement that is always true is

A. $a^2 + o^2 = b^2$
B. $b^2 - o^2 = a^2$
C. $a^2 + b^2 = o^2$
D. $a^2 - b^2 = o^2$

11. The standard form of the equation of the circle on P(8,0), R(4,-4) and the origin is

A. $(x-4)^2 + y^2 = 4^2$
B. $(x+4)^2 + y^2 = 4^2$
C. $x^2 + (y-4)^2 = 16$
D. $(x-4)^2 + (y-8)^2 = 4$

12. The hyperbolas which are related in such a way that the transverse axis of one is the conjugate axis of the other and conversely, are called

A. rectangular hyperbolas
B. conjugate hyperbolas
C. similar hyperbolas
D. none of the above

13. The modulus of $a + bi$, $i = \sqrt{-1}$ is

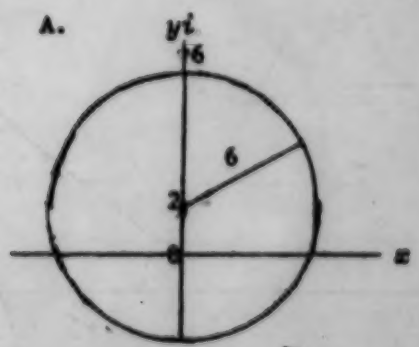
A. $|a + b|$
B. $|a^2 + b^2|$
C. $\sqrt{a^2 + b^2}$
D. $\sqrt{a^2 - b^2}$

14. The general form of the equation of a circle is

A. $x^2 + y^2 - gx - fy + c = 0$
B. $(x-h)^2 + (y-k)^2 = r^2$
C. $x^2 + y^2 + 2gx + 2fy + c = 0$
D. $x^2 - y^2 + 2gx + 2fy - c = 0$

15. The graph of the set $A = \{z \mid |z + 2i| = 6, z \in C\}$ is

A.



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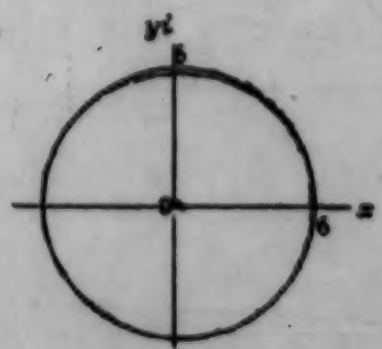
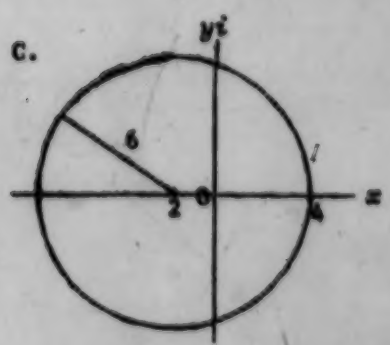


C.



D.